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ABSTRACT

This report on Compensatory Education (CE) examines the cost effectiveness of instructional programs and outcomes for reading and mathematics. Included are a description and comparison of services for elementary school students in Title I programs, other CE programs and regular instruction programs. Also reported are the results of student academic achievement as measured by Form S of the Comprehensive Tests of Basic Skills, fall and spring percentile norms and vertical scale conversions based on the projected national score distributions from the SES in the first year of the study. Cost effectiveness is assessed by subsetting the student sample in terms of multiple displays of average costs and achievement scores, and by estimating regression coefficients which relate achievement gain to cost. It is concluded that where program costs are held constant, funding source does not appear to have an independent effect on educational outcome. It is also suggested that CE is relative more cost effective in the lower grades. (Author/JCD)

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AN ANALYSIS OF THE COST AND EFFECTIVENESS OF COMPENSATORY EDUCATION

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Leonard S. Klibanoff
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**TECHNICAL REPORT # 7
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SUSTAINING EFFECTS OF COMPENSATORY
EDUCATION ON BASIC SKILLS**

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A PRECIS OF THE SUSTAINING EFFECTS STUDY AND AN OVERVIEW OF THE PRESENT VOLUME

The Sustaining Effects Study

In response to questions about education policies, SDC has studied compensatory education (CE); its nature, quantity, and environment; its sustained effects; and its generality, in a large study called: The Sustaining Effects Study. This thorough study will result in a series of reports from the following substudies:

The Longitudinal Study. In the Longitudinal Study, the educational achievements of children will be assessed in the fall and spring for three consecutive years. The children will take an achievement test in reading and mathematics, a functional literacy test, and a measure of attitude toward school and toward themselves as students. The amount and nature of instruction in reading and mathematics will be determined for each student four times during the school year. In addition, teachers and principals will report on their practices of instruction and teaching. Thus, it will be possible not only to assess student growth over a three-year period, but to relate this growth to the kinds and amounts of instruction being received.

The schools in the study were drawn from three different groups. The **Representative Sample** of schools is a sample carefully drawn to represent all of the nation's public schools having some of the grades one through six. A second group of schools, the **Comparison Sample,** is composed of schools that have large proportions of students from poor homes but do not receive special funds to offer CE services. The third group is the **Nominated Sample,** composed of schools nominated because their educational programs had promise of being effective for low-achieving students. During the first year of the study, data were collected from 328 schools and about 118,000 students.

The Cost/Effectiveness Study. Information is being obtained on the resources and services to which each student is exposed during reading and mathematics instruction. Cost estimates will be generated on the basis of this information. Because the effectiveness of the instructional programs is to be determined in the Longitudinal Study, it will then be possible to relate the effectiveness to the cost of each program.

The Participation Study. The purpose of the Participation Study is to determine the relationships among economic status, educational need, and instructional services received. The educational achievement of the students and the services they receive will be obtained in the Longitudinal Study, but the refined measures of economic status will be obtained in the Participation Study. A random sample of over 15,000 students was drawn from the schools in the first-year **Representative Sample** and visits were made to the homes of these students. During the visits, information was collected on the economic level of the home and on the parents' attitudes toward their children's school and learning experiences. Thus, the level of student achievement and services can be related to the economic level of the home from which the student comes.

The Summer Study. The Sustaining Effects Study also examines the effectiveness and cost-effectiveness of summer-school programs. RMC Research, responsible for conducting the summer study, is investigating questions about summer school. Information about the 1977 summer school experiences of the SES students is being combined with other SES data. The resource cost model, developed for the regular-year cost-effectivness studies, is being adapted to the needs of the summer school study.

The Successful Sites Study. This study is to identify and describe the instructional practices and contexts that appear to be effective in raising the reading and math achievements of educationally disadvantaged students. In-depth observational and interview data will be collected from approximately 50 schools that are participating in the Sustaining Effects Study.

OVERVIEW OF THE PRESENT VOLUME

This is the seventh technical report in a series of reports from the Study of the Sustaining Effects of Compensatory Education on Basic Skills. It reports on analyses of the cost and the effectiveness of compensatory education (CE). The study focuses on students in the elementary grades, but examines instructional programs and outcomes only for reading and math. The emphases are on describing and comparing services for students in Title I programs, Other-CE programs, and regular-instruction programs.

THE FOCUS AND METHODS OF THIS STUDY

A set of policy-relevant questions guided the analyses and the overall search for relationships between resource-use and outcomes. The questions are:

- To what extent is the use of instructional resources associated with growth in student achievement?
- What particular combinations of resources are more cost-effective for increasing growth in student achievement?
- At what grade level is compensatory education more cost-effective?
- Does funding source, holding resource costs constant, have any independent effect on educational outcome?

The data for this report are for the 1976–77 school year. The sample includes over 95,000 students, about equally distributed over the six grades, from 314 schools. The schools are categorized by their source of funding—Title I, Other-CE (only) or no-CE funding. The students are categorized by whether they were selected to receive CE services and, for those receiving CE services, whether funding is from Title I or Other-CE programs. Thus, each student in the study can be classified into one of six CE selection categories based on the school attended and selection for services. The student CE selection categories and the numbers of students in each are:

Selection Categories	Number of Reading Students	Number of Math Students
Selected for CE Services		
Title I students in Title I schools	14,796	8,552
Other-CE students in Title I schools	4,918	4,438
Other-CE students in Other-CE schools	3,634	2,153
Not selected for CE services		
Non-CE students in Title I schools	38,309	45,148
Non-CE students in Other-CE schools	21,070	22,430
Non-CE students in Non-CE schools	12,359	12,370
Totals	95,086	95,091

Other categories were also employed in the analyses: initial achievement status, family economic status (using participation in free or reduced-price lunch programs as a surrogate variable), high and low residual gain, program cost, and instructional configuration (combinations of resources).

Cost Measurement. The strategies used in estimating cost are designed to address deficiencies identified in previous studies. A program cost is estimated for each student who receives reading or math instruction. This cost is a dollar-metric that reflects student exposure to resources, and is expressed in standard resource dollars (SRDs). It is based on data collected on the amount of instructional time the student spends in groups of different sizes with different instructors, and the use frequencies for equipment and materials. Dollar values are assigned (using standard prices for comparable resources) to a student's instructional program only after the kinds and quantities of resources utilized in that program have been specified.

Because we aggregate the resource quantities used at the student and classroom levels and then calculate the cost of these resources, the results are different from those obtained by dividing the dollar expenditures for an instructional or school program by the number of students enrolled. The cost we calculate includes only those resources that differentiate one student's instructional program from another's. It does not include, for example, the cost of classroom space or the cost of administration of programs or schools.

Outcome Measures. Student academic achievement in reading and math was assessed by Form S of the Comprehensive Tests of Basic Skills (CTBS). Fall and spring percentile norms and vertical-scale conversions were developed, using the projected national score distributions from the SES in the first year of the study. In addition, during the first year, at-level and below-level tests were administered. An analysis of these test scores resulted in the selection of a recommended-level test score for each grade at each school. In order to reduce floor and ceiling effects, the recommended-level test scores are used in this report.

Analysis Approach. The analyses were designed to provide two avenues for examining cost and effectiveness. The first avenue is by means of multiple displays of average costs and achievement scores for various ways of subsetting the student sample; this might be termed a cost/gain reporting approach. The second avenue is to postulate regression models that

relate achievement gain to cost, calculate estimates of the regression coefficients for cost, and then let the estimated coefficients serve as indices of cost-effectiveness. The regression models were of the following general forms:

Posttest: posttest = f(cost) + g(pretest) + error

Raw Gain: posttest − pretest = f(cost) + error

Residual Gain: posttest − expected posttest = f(cost) + error

where cost is expressed as total program cost or disaggregated into ten program component costs. The posttest model was used most often.

FINDINGS

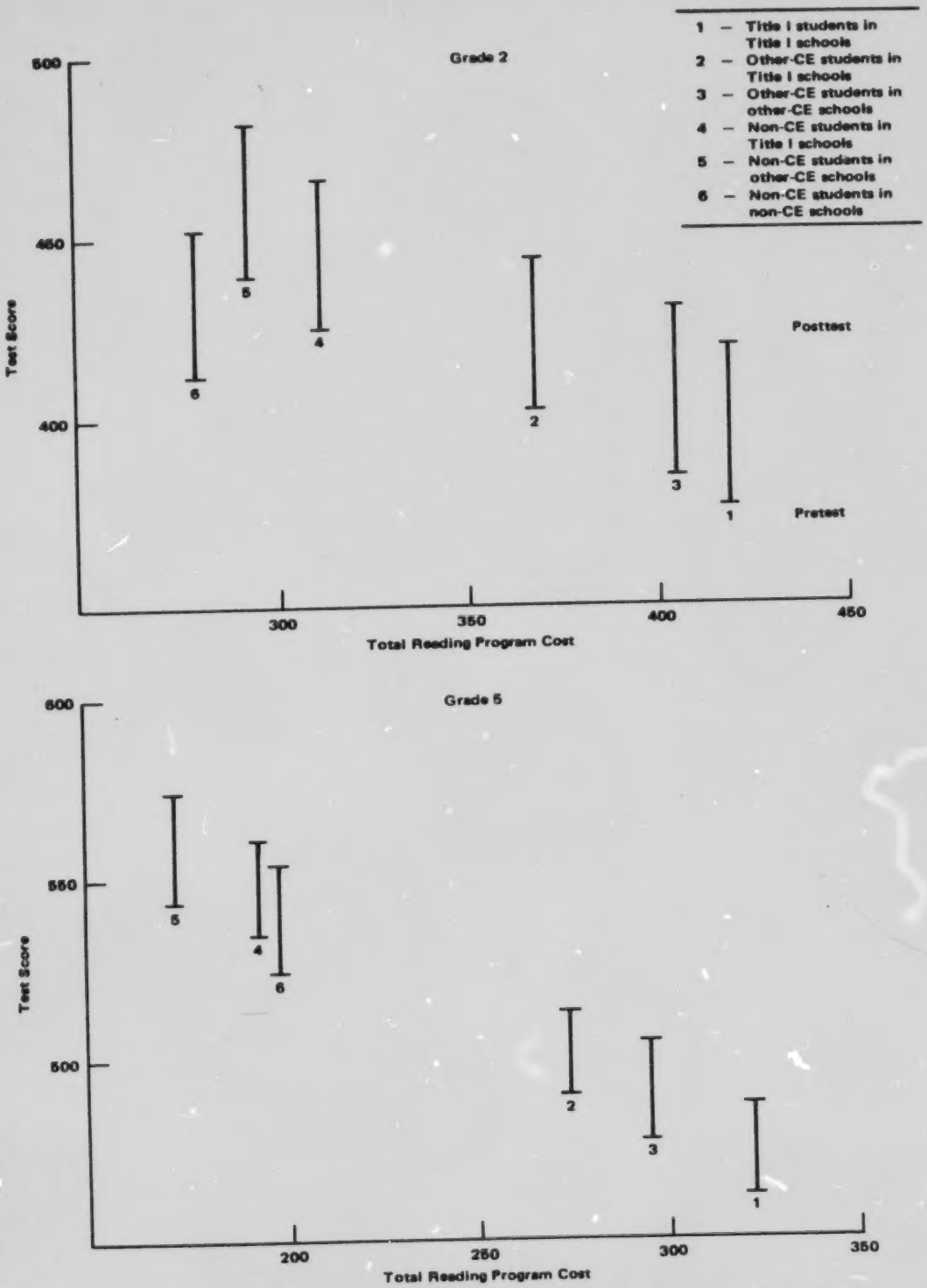
Our results have been nondecisive in the sense that none of our comparisons among groups of students reveal meaningful differences in cost-effectiveness. On the other hand, we are not quite prepared to conclude that the level of resource utilization has no independent effect on outcome. Though small, the raw regression coefficients that served as our indices of cost-effectiveness frequently exceeded two and three times their standard errors, and were often disturbingly negative.

A probable explanation for the slight negativity is that, *on balance,* resources tend to be allocated with more intensity to low achievers. The allocation is dynamic across time, depending on student performance: low achievers who show marked improvement move on to less labor-intensive instructional programs; students in less labor-intensive programs who progress slowly are reassigned to more expensive programs. According to this view, the allocation effect swamps whatever therapeutic effects resource utilization might have. The allocation would operate within classrooms, and therefore could dominate within most of our blocking arrangements as well as over grade levels taken as a whole.

We now turn to a summary discussion of our results as they apply to the four policy-research questions presented earlier.

To What Extent Is the Use of Instructional Resources Associated With Growth in Student Achievement?

An examination of the data indicates that CE students learn about as much during each school year as non-CE students, but the differences between them in achievement status that exist at the beginning of the year persist, despite the growth exhibited during the school year. The costs of the reading and math programs received by the CE students, however, are substantially greater (especially in reading; less so in math) than the program costs for the non-CE students. A graphic representation of these results is provided for second-and fifth-grade reading in the following figure. Reading-program cost is measured along the horizontal axis, and achievement test scores (pretest and posttest) are measured along the vertical axis. Average pretest and posttest scores for each grouping are plotted against average program cost, and a vertical line joins the pretest and posttest points. Achievement data and costs are plotted in this manner for the six CE selection categories and for the total sample. The results are similar for the other grades; in math, the inverse relationship of test score to cost is somewhat less pronounced.



Reading Achievement Performance *Versus* Program Cost by CE Selection Category, Grades 2 and 5

The regression coefficients of our cost variable are small and most often negative, whether considered for the full complement of students in each grade or for the policy-relevant subsets of students in the analyses. Regressions yield very similar results, whether the dependent measure is specified as posttest score, residual gain, or raw gain, and whether the models are linear or curvilinear. (See table below.)

Average Regression Coefficients for Total Program Cost Predicting Reading and Math Outcomes

Reading total program cost predicting:	
Reading posttest	−.011
Reading raw gain	−.004
Reading residual gain	−.011
Math total program cost predicting:	
Math posttest	−.017
Math raw gain	−.013
Math residual gain	−.017

In comparing students who gained much more than was projected from their pretests with those who gained much less, it was found that the high-gainers generally received programs with lower costs. Notable exceptions were in grades three through six, where the Title I students who were high-gainers received the higher cost programs.

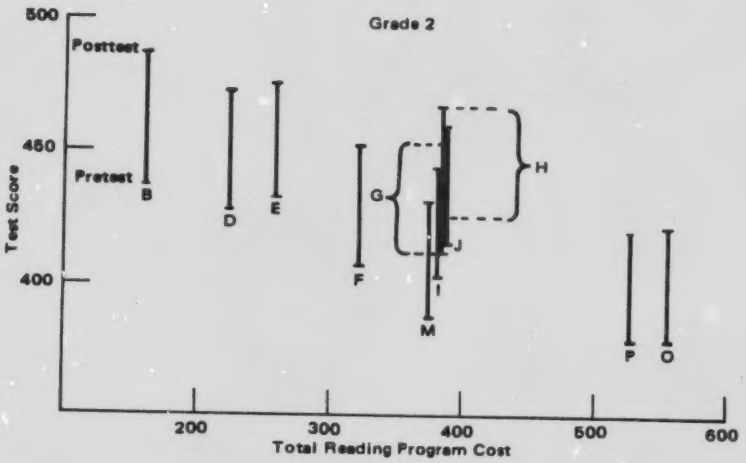
What Particular Combinations of Resources Are More Cost-Effective for Increasing Growth in Student Achievement?

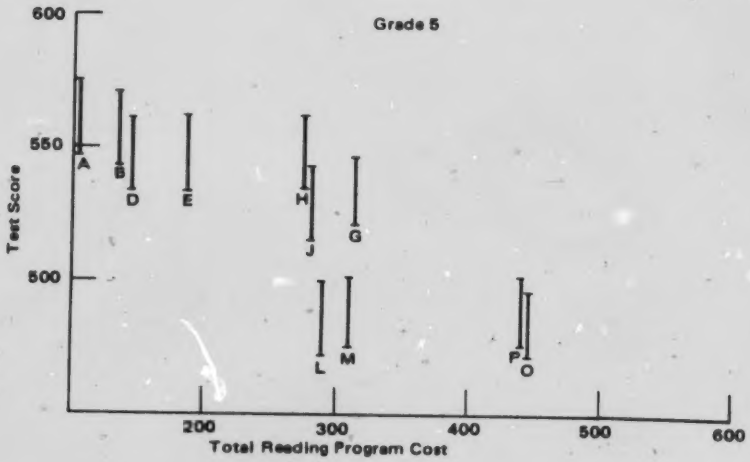
Analyses of students blocked by instructional configuration (combinations of resources) yielded results consistent with those obtained from the regressions against total program cost. When average pretest and posttest scores for the various configurations are charted against average program cost (see Figure below), it is clear that, on balance, the more expensive configurations are employed for students with lower pretest scores. This tendency, which holds for both reading and math, is more pronounced in the upper grades. The exception is that students in configurations that employ individualized instruction by the regular teacher tend to have higher pretest scores than do students in configurations that employ special teachers, although the average costs for the two kinds of configurations are about the same.

Regression computations were performed with the posttest score as the dependent variable, with the pretest score and total reading (and math) program cost as the independent variables. The regression coefficients for cost that resulted were of trivial magnitudes.

A second set of regressions specified the ten separate program component costs rather than total program cost. The program component costs result in somewhat higher regression multiple R^2 for the configurations, but the proportions of posttest variance explained by the cost variables (net of variance explained by pretest score) were minimal for all configurations in all grades.

A. Minimal program with no seatwork.
B. Minimal program with seatwork.
D. Group instruction with no seatwork.
E. Group instruction with seatwork.
F. Group instruction plus aide.
G. Individual instruction with no seatwork.
H. Individual instruction with seatwork.
I. Individual instruction plus aide.
J. Individual instruction plus group instruction.
L. Special teacher.
M. Special teacher plus group instruction.
O. Individual instruction and special teacher.
P. Individual instruction and special teacher plus group instruction.





Reading Achievement Performance *Versus* Program Cost by Instructional Configuration for Grades 2 and 5

At What Grade Level Is Compensatory Education More Cost-Effective?

We intended to examine this question by first making within-grade contrasts between regression coefficients (i.e., "indices of cost-effectiveness") for CE and non-CE student program costs, then comparing these contrasts across grade levels. Our design does not work well because the coefficients turned out to be small and relatively unstable for the CE subsample. Summary achievement and cost data (condensed from Tables 4-1 and 4-2) are presented in the table below for CE students and for a special comparison group of non-CE students. The latter group consists of non-CE students in non-CE schools who are judged by teachers to be in need of CE services. In examining raw gain alone, CE students at all grade levels gain an equal or greater amount than does the comparison group.

The differences are largest in the early grades. Comparing the same groups for cost per unit of gain, the differences are smaller in the lower grades for both reading and math, suggesting that CE may be relatively more cost-effective in the lower grades.

Does Funding Source, Holding Resource Costs Constant, Have an Independent Effect on Educational Outcome?

This question, which most closely relates to an analysis of the overall effectiveness of programs defined by funding category, was included in the analysis as a test of our underlying assumption that it is not the *type* of funding but, rather, the *level* or the use of funds that would prove important in relation to student outcomes.

Funding source, holding program costs constant, does not appear to have an independent effect on educational outcome (refer again to first figure). In those analyses that subset our sample of students within grades according to their CE selection status (Title I, Other-CE, and non-CE), the results across selection categories were quite similar. This is in spite of large cost differences as well as differences in pretest levels across categories. In terms of the raw differences between pretest and posttest mean achievement scores, CE students appear to be learning as much as non-CE students, except in the first grade. In the regression analyses, results were similar for all groups of students, including those not participating in any CE program.

On the whole, consistent differences in the relations of program cost to achievement growth were not found among CE programs funded from different sources.

Achievement and Cost Data for Reading and Math for CE Students and Comparison Students, by Grade

CE Status	Achievement Data		Program Cost	
	Pretest Mean	Raw Gain	Mean Cost	Cost-Gain Ratio
	Reading			
Grade 1				
CE Students	329	59	406	7
Comparison Students	321	54	330	6
Grade 2				
CE Students	387	43	407	9
Comparison Students	377	39	292	7
Grade 3				
CE Students	422	35	371	11
Comparison Students	415	31	298	10
Grade 4				
CE Students	447	31	342	11
Comparison Students	442	30	246	8
Grade 5				
CE Students	474	25	308	12
Comparison Students	463	23	223	10
Grade 6				
CE Students	499	25	288	11
Comparison Students	494	25	204	8
	Math			
Grade 1				
CE Students	316	61	187	3
Comparison Students	308	49	142	3
Grade 2				
CE Students	372	54	190	4
Comparison Students	365	45	145	3
Grade 3				
CE Students	415	54	205	4
Comparison Students	410	50	167	3
Grade 4				
CE Students	457	49	222	5
Comparison Students	456	49	160	3
Grade 5				
CE Students	498	43	234	6
Comparison Students	487	37	153	4
Grade 6				
CE Students	535	41	208	5
Comparison Students	533	33	153	5

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CHAPTER 1. INTRODUCTION

PURPOSE OF THIS REPORT

This report documents an investigation of the relationship between resource utilization and educational outcome, and provides information on the relative cost and effectiveness of alternative compensatory and non-compensatory instructional programs. The emphases are on describing Title I and other compensatory education (CE) funded services and on comparing CE education services with those of regular education. The programs being compared utilize different levels and combinations of resources to provide reading and math instruction for students in grades one through six.

The analyses of cost and effectiveness were done by the RMC Research Corporation as part of the Sustaining Effects Study (SES). Technical Report # 6 (Haggart, Klibanoff, Sumner, and Williams, 1978) documents how measures of the individual student's use of resources were translated into estimates of cost. This translation, using standard prices for comparable resources, provides the dollar-metric (expressed in standard resource dollars—SRDs) needed for analyzing the relationship between cost and effectiveness.

The outcomes of primary interest are the achievement test scores for reading and math. The measure employed for all students is the Comprehensive Tests of Basic Skills (CTBS).

The presentation of analyses and results are organized by levels of cost-data aggregation and levels of students. The two cost levels of aggregation are program cost (reading or math) and component cost. The highest aggregation of students is an entire grade in the SES sample, with lower aggregations separating those that receive CE services from those that receive regular instruction. We have also focused on several smaller subsets of students.

A set of policy-relevant questions guided the analyses and the overall search for relationships between resource-use and outcomes. The questions are:

- To what extent is the use of instructional resources associated with growth in student achievement?
- What particular combinations of resources are more cost-effective for increasing growth in student achievement?
- At what grade level is compensatory education more cost-effective?
- Does funding source, holding resource costs constant, have any independent effect on educational outcome?

The *research* nature of this study should be noted. As is discussed in Chapter 2, the conclusions of past studies seeking to determine relationships between resources and outcomes have been ambiguous. In our assessment of the more important studies, we delineated what we consider to be their shortcomings; our research approach incorporates specific remedies we hope will overcome some of the deficiencies.

SCOPE OF THE STUDY

The SES provides a data base that is rich in terms of quantity and quality. The structure of our analyses is described in detail in Chapter 3, but the scope of the study is briefly discussed here to provide the reader with a general picture.

The Schools

The data for this report are from the 1976-77 school year. The sample includes over 95,000 students from the 314 schools of the three subsamples of the SES: the **Representative Sample,** the **Nominated Sample** and the **Comparison Sample.**

The sampling procedures and the nature of the subsamples are reported in detail in Technical Report # 1 by Hoepfner, Zagorski, and Wellisch (1977). The 242 schools in the Representative Sample were selected probabilistically from among all schools in the nation that serve one or more of the six elementary grades. A three-dimensional factorial sampling design was employed, with the sampling frame stratified by region (ten levels), school district ADA (three levels), and poverty status of school district (three levels). The sampled schools were subsequently classified as being Title I schools (157 schools with CE funding from both Title I and (frequently) other programs), Other-CE schools (56 schools with CE funding only from non-Title I programs) and non-CE schools (29 schools with no CE funding).

The Nominated Sample includes 43 schools selected by nomination because of their exemplary reading or math programs. The Comparison Sample includes 29 schools selected on the primary criterion of being eligible for, but not receiving, extensive compensatory funding.

The Students

In addition to being identified by the school they attend, the students are further categorized by whether they were selected to receive CE services and, for those receiving CE services, whether funding is from Title I or Other-CE programs. Thus, each student in the study can be classed into one of six CE selection categories based on the school attended and selection for services. The student CE selection categories are:

Selected for CE services

- Title I students in Title I schools
- Other-CE students in Title I schools
- Other-CE students in Other-CE schools

Not selected for CE services

- Non-CE students in Title I schools
- Non-CE students in Other-CE schools
- Non-CE students in non-CE schools

The distribution of our sample by grade, by selection or non-selection for CE services, and by the category of school attended is shown in Table 1-1.

Table 1-1

Numbers of Students by Selection Category and Grade

Selection Category	Gr. 1	Gr. 2	Gr. 3	Gr. 4	Gr. 5	Gr. 6	Total
	Reading						
Title I Students in Title I Schools	2,743	2,923	2,861	2,306	2,069	1,894	14,796
Other-CE Students in Title I Schools	970	883	822	776	675	792	4,918
Other-CE Students in Other-CE Schools	551	696	612	602	573	600	3,634
Non-CE Students in Title I Schools	7,075	5,873	5,797	6,274	6,564	6,726	38,309
Non-CE Students in Other-CE Schools	3,146	2,799	2,864	3,109	3,531	5,621	21,070
Non-CE Students in Non-CE Schools	2,103	1,897	1,896	1,867	2,143	2,453	12,359
Total	16,588	15,071	14,852	14,934	15,555	18,086	95,086
	Math						
Title I Students in Title I Schools	1,553	1,585	1,681	1,392	1,247	1,094	8,552
Other-CE Students in Title I Schools	842	734	669	740	645	808	4,438
Other-CE Students in Other-CE Schools	326	286	353	363	388	437	2,153
Non-CE Students in Title I Schools	8,403	7,383	7,166	7,254	7,468	7,474	45,148
Non-CE Students in Other-CE Schools	3,378	3,217	3,154	3,341	3,725	5,615	22,430
Non-CE Students in Non-CE Schools	2,086	1,886	1,888	1,882	2,171	2,457	12,370
Total	16,588	15,091	14,911	14,972	15,644	17,885	95,091

We deleted from the sample all students who were missing pretest scores, posttest scores, or cost information. The result was a decrease from an initial sample of approximately 108,000 to one of 95,000. About the same number of students are in our sample for the analyses of reading instruction as for math instruction. The distribution of students by grade is similar for reading and math, with approximately 18,000 students in the 6th grade, 16,500 in the 1st grade and 15,000 in each of grades two through five.

INSTRUMENTS USED IN THIS STUDY

The instruments for the SES are of two types, depending on the use of the information they supply. One group contributes information on the instructional programs; the other group describes the students and their environments. To aid the reader in understanding how the measures of instructional programs at the student level were obtained, several of the instruments are discussed in the following paragraphs; the instruments, themselves, are published in Technical Report # 9A, *A Compilation of the Instruments Used in the Sustaining Effects Study*. (Staff of the Sustaining Effects Study, 1979).

Instruments Describing a Student's Instructional Program

Six instruments used in the SES form the core of the resource information on the instructional program. Five obtain information on the resources for an individual student's reading and math instructional program. The sixth instrument, the Student-Teacher Linkage Roster (STLR), links a student to the specific teacher or teachers providing the instruction. The purpose of each of these six instruments is shown in Table 1-2.

Table 1-2

The SES Instruments Used to Construct the Resource Measures of Instructional Programs

Instrument	Purpose
Teacher Questionnaire—Section A (TQA)	Records teacher characteristics
Teacher Questionnaire—Section B (TQB)	Records characteristics of each reading teacher's reading program
Teacher Questionnaire—Section C (TQC)	Records characteristics of each mathematics teacher's math program
Principal Questionnaire B (PQB)	Records characteristics of the school's students, staff and programs
Student Participation and Attendance Record (SPAR)	Records the student's exposure to reading and math instruction by time, teacher and group size
Student Teacher Linkage Roster (STLR)	Links each student with up to three reading and three math teachers

The Student-Teacher Linkage Roster (STLR) is the key to the generation of the dollar measures for reading and math instruction for each student in the study. Through the STLR, we are able to link the teacher's description of the student's program, as given on the Student Participation and Attendance Record (SPAR), with the characteristics of the teachers' program, obtained from Teacher Questionnaire B (TQB) for reading, and Teacher Questionnaire C (TQC) for math.

Instruments Describing the Student and Environment

The characteristics of each student (school, economic and home environments) are available in the SES data base. They were obtained from the other SES instruments, which are listed below according to their use in the analyses.

To provide student characteristics:

Compensatory Education Roster (CER)

Comprehensive Tests of Basic Skills—Reading (CTBS)

Comprehensive Tests of Basic Skills—Math (CTBS)

Practical Achievement Scale (PAS)

Student Affective Measures (SAM)

Student Background Checklist (SBC)

Summer Activity Slipsheet (SAS)

To provide characteristics of district, school, economic and home environments:

District Characteristics Questionnaire A (DCHA)

District Characteristics Questionnaire B (DCHB)

District Expenditure Information Questionnaire (DEX)

Household Information Questionnaire (HIQ)

Principal Questionnaire Section A (PQA)

The Compensatory Education Roster (CER) indentifies the CE selection status for each student; these data, coupled with the category of school attended, provide the CE selection category for each student in the SES. An assignment to a CE selection category remains the same throughout our analyses. Data obtained from the instruments measuring outcome are used directly in the analyses. Data from the other instruments are used to develop the independent and stratifying variables of the analyses.

The Cost Estimates

The instructional program cost is a measure of the resources used in providing instruction. The strategies used in estimating cost, discussed in Chapter 3, are designed to overcome deficien-

cies identified in the next chapter. The cost, in standard resource dollars, permits the equitable cost comparisons we need in our analyses. A more complete discussion, emphasizing the nature of the resource cost model (RCM) used in the translation of resource-use measures to cost, is presented in Appendix A.

Depending on the needs of a particular analysis, instructional program cost is provided as a total cost of all the resources used or as a cost by program component (this cost information is shown in Appendix B). The cost by program component permits an examination of the total program cost in terms of the cost of specific delivery modes, such as instruction by a classroom teacher in a large group, or by a special teacher in a medium group.

The Outcome Measures

Student academic achievement in reading and math was assessed by Form S of the Comprehensive Tests of Basic Skills (CTBS). A special SES effort identified and eliminated items thought to be racially or culturally biased. The debiased test scores are used in the analyses of this report. Fall and spring percentile norms and vertical-scale scores (VSSs) were developed, using the projected national score distributions from the SES students in the first year of the SES.

In addition during the first year, each student was given two tests, one designated by the publisher as the student's grade level, and the other designated as one grade level lower. Analysis of these test scores resulted in the selection of a recommended-level test score for each grade at each school. In order to reduce floor and ceiling effects, the recommended-level test scores are used in this report. In sum, the reading and math scores used are the debiased, vertical-scale, recommended-level CTBS test scores. A full description of the measures of achievement may be found in technical Report # 9, *The Measures and Variables in the Sustaining Effects Study,* (Hemenway, Wang, Kenoyer, Hoepfner, Bear and Smith, 1978).

Two other outcome measures were developed and used in the SES—the Practical Achievement Scale (PAS) and Student Affective Measures (SAM). The PAS scores, highly correlated with the achievement scores, were felt to add an expensive but only marginally useful indicator of impact to the cost/effectiveness analyses and are not used in this report. The SAM, with scales for attitude toward reading, attitude toward math, and attitude toward school, also has subscale and total scores. The strong correlations of subscale-to-total score (and among the three subscale scores) indicate that total score alone could be used without any loss of information.

CALCULATION OF COST ESTIMATES

The cost estimates used in the analyses of this report (Table 1-3) are different from the cost estimates reported in Technical Report # 6, (shown in parentheses in Table 1-3). In the earlier report, the purpose was to describe and analyze the cost for the instructional programs *offered* to students, hence the cost calculations presumed that each student exhibited perfect school attendance. In this report, we analyze the outcomes resulting from the student's *actual exposure* to the resources; cost calculations are based on actual attendance. For cost/effectiveness analyses, it is clearly preferable to use cost estimates that reflect the amount of resources actually used.

Table 1-3

Mean Student Program Costs in Standard Resource Dollars by Selection Category and Grade (Costs in Parentheses are Based on Larger Sample, on Variable Teacher Salaries, and on an Assumption of Perfect Attendance)

Selection Category	Gr. 1	Gr. 2	Gr. 3	Gr. 4	Gr. 5	Gr. 6
	Reading					
Title I Students in Title I Schools	416 (459)	420 (469)	378 (411)	359 (399)	322 (344)	319 (361)
Other-CE Students in Title I Schools	378 (405)	367 (402)	346 (374)	311 (335)	277 (313)	234 (234)
Other-CE Students in Other-CE Schools	405 (469)	405 (451)	370 (411)	319 (360)	294 (318)	261 (292)
Non-CE Students in Title I Schools	325 (349)	311 (336)	255 (272)	202 (221)	188 (201)	162 (167)
Non-CE Students in Other-CE Schools	314 (355)	290 (324)	242 (256)	183 (204)	167 (187)	162 (183)
Non-CE Students in Non-CE Schools	302 (332)	275 (296)	249 (271)	192 (203)	195 (208)	165 (180)
	Math					
Title I Students in Title I Schools	209 (206)	212 (214)	217 (240)	239 (258)	266 (273)	246 (260)
Other-CE Students in Title I Schools	144 (150)	141 (155)	174 (179)	196 (213)	194 (205)	172 (187)
Other-CE Students in Other-CE Schools	190 (210)	197 (212)	204 (218)	211 (233)	200 (213)	180 (195)
Non-CE Students in Title I Schools	132 (138)	140 (146)	134 (143)	139 (151)	141 (153)	133 (144)
Non-CE Students in Other-CE Schools	116 (128)	120 (132)	127 (135)	121 (132)	126 (135)	118 (131)
Non-CE Students in Non-CE Schools	128 (144)	132 (135)	138 (147)	136 (147)	144 (166)	135 (150

Cost estimation in this report differs from that of Technical Report # 6 in one additional aspect. The variable-salary structure for teaching personnel (in which salary is adjusted for amount of education and experience) has been abandoned in favor of a constant-salary basis. The constant-salary basis (a single salary or price factor for all teachers) is more appropriate for the analyses relating outcomes to cost. This judgment is based on a lack of empirical support for across-the-board relationships of student achievement to the characteristics (experience, educational attainment) that determine teacher salaries.

The cost values shown in Table 1-3 differ in a third regard that is unrelated to the estimation process, per se. Namely, the costs in Table 1-3 are for students from all subsamples of the SES—the Representative, Nominated, and Comparison Samples. The cost data presented in Technical Report # 6 were based on students from schools in the Representative Sample only.

The data indicate that the changes in the basis for estimating cost had the expected effect. The mean student program costs were reduced, which resulted from using actual as opposed to assumed attendance, and from using a constant salary for all teachers. Generally, the reductions are on the order of six to ten percent of the values in Technical Report # 6.

ORGANIZATION OF THE REMAINDER OF THIS REPORT

Chapter 2 reviews previous studies of the relationships between costs and outcomes in education. Chapter 3 contrasts the basic approach of this study with those of the earlier studies, and discusses the particular analytic strategies employed. The results of our analyses are presented in Chapter 4, and their relevance to policy are discussed in Chapter 5. A list of references is followed by two appendices: a description of the Resource Cost Model, and a summary presentation of average costs of reading and math program components for each of the six CE selection status categories.

CHAPTER 2. REVIEW OF PAST STUDIES

A review of past studies of the relationships between educational resources and outcomes was undertaken in support of the development of the study plan. The review was intended to identify important variables for our analysis and to isolate those shortcomings in the designs of earlier studies that needed to be overcome.

This review is organized into two parts. We first present a brief review of the details and results of some studies that bear on the relationships between resources and educational outcomes. We first examine early studies and then proceed to more recent studies. We then follow with a summary of the critical problems in the design of those studies and a description of the steps incorporated in the SES to resolve them. We should note, however, that this review is intended precisely for the above-mentioned purposes; it is not intended to provide an exhaustive treatment or synthesis of efforts to evaluate the effectiveness (or cost/effectiveness) of Title I or other compensatory efforts. A recent three-volume report by McLaughlin and his colleagues provides such a synthesis with respect to Title I (McLaughlin, 1978; McLaughlin, Gilmartin, and Rossi, 1977; Rossi, McLaughlin, Campbell, and Everett, 1977).

In presenting the results of our review of earlier studies, we first discuss those studies that, in effect, predate any formal concern with the effects of CE. Most notably, we discuss the *Equality of Educational Opportunity Survey (EEOS),* (Coleman et al., 1966) and the results of the many reanalyses of the data collected in that survey. Our intention here is to establish the background of relatively inconclusive findings. It is to these studies that the well-known summary offered by Averch and his colleagues (Averch, et al., 1972) applies, that "No single resource consistently appears to exert a powerful influence on student outcomes . . . (while) some school resources appear to be important in each study, the same resources appear to be unimportant in other studies (p. 48)". That discussion is followed by an examination of other more recent studies that have either taken the effects of CE and/or costs as major points of reference or that have, in some manner, employed alternative methods in examining cost/effectiveness relationships.

EARLY STUDIES—NOT CONCERNED WITH COMPENSATORY EDUCATION

A number of studies, most notably the EEOS Report (Colemen, et al., 1966) have attempted to incorporate the economist's notion of the 'production function' into research on school effects. These input-output studies treat schools as black boxes into which resources (at defined costs) are put and out of which outputs flow, most often in the form of student achievements. This early body of research on the relationships between educational inputs and outputs has largely been responsible for the general finding that schools are relatively ineffective with respect to outcomes. In order both to identify important variables for our analysis and to facilitate our later discussion of deficiencies in research design, we will first summarize the main result of these studies.

The EEOS Report received much notoriety by reporting that: (1) home-environment variables (family background) were the most important factors in determining academic achievement; (2) the influence of school variables on achievement was less than that of family background;

and (3) among variables associated with school, those reflecting characteristics of the student body were more important than teacher characteristics or characteristics of the school's facilities or curricula.

Much of the negative response to the EEOS Report has centered on criticisms of their data analysis procedures. The main criticisms question the selection and implementation of a variance-analytic technique for determining the importance of variables in producing educational outcomes. Also, the method used to assess the importance of classes of variables in relation to achievement has been criticized for a lack of direct policy relevance (Cain and Watts, 1968; Hanushek and Kain, 1972) and for an ordering procedure favoring background factors over school factors (Bowles and Levin, 1968).

The criticisms of the report notwithstanding, the EEOS Report has indeed provided a basis for questioning the relationship of educational resources to educational outcomes. Among the school resource variables frequently included in these earlier input-output studies are teacher characteristics such as training, average experience, salary, degree, and verbal ability. Average class size and measures of the school's resources are also frequently included. Findings on these are discussed below.

With respect to *teacher characteristics,* attempts have been made to associate the salary-determining characteristics (educational attainment, seniority) with outcome. The results are quite mixed. At least six studies (Thomas, 1962; Burkhead, et al., 1967; Hanushek, 1968; Katzman, 1968; Levin, 1970; and Michelson, 1970) have reported at least some statistically significant effects due to teacher experience. However, four studies reviewed (Kiesling, 1969, 1970; Hanushek, 1970; and Averch and Kiesling, 1970) report non-significance for teacher experience.

At least four studies have examined the effect of level of college degree and have not detected statistical significance (Burkhead, et al., 1967; Katzman, 1968, Kiesling, 1969, 1970). Similar results may be found for teacher certification, with at least five studies reporting no statistically significant relationships. However, when the number of college hours in the *subject taught* was employed as a proxy for certification, a statistically significant relationship was found (Kiesling, 1970). The verbal ability of teachers, which may or may not be considered a resource, has shown a consistent relationship to outcome. For example, significant relationships of this variable to achievement have been reported in reanalyses of the Coleman data (Hanushek, 1968; Bowles, 1969; Levin 1970) and by Hanushek (1970).

Class size has a considerable effect on the costs of running schools. It has been the subject of numerous studies attempting to determine whether smaller class size is related to higher achievement. The pupil/teacher ratio is frequently used as a measure of class size. Among the nineteen studies reviewed by Averch, et al. (1972), this variable was significant in four (Thomas, 1962; Mollenkopf and Melville, 1956; Bowles, 1969; Averch and Kiesling, 1970); but was insignificant in eight others (Benson, et al., 1965; Coleman, et al., 1966; Burkhead, et al., 1967; Katzman, 1968; Raymond, 1968; Kiesling, 1969, 1970; Cohen, 1968).

If we turn our attention to other measures of school resource consumption, the same lack of consistent relationships appears. The per-pupil expenditure on books and supplies has proven

insignificant in at least four studies (Burkhead, et al., 1967; Kiesling, 1969; Levin, 1970; Averch and Kiesling, 1970), and yet one study reports a significant relationship (Fox, 1969). Studies that examined the effect of school facilities yield similarly inconsistent results. The same is true for studies that measured school cost by districtwide per-pupil expenditures. Effects due to expenditures were not significant when the wealth and location of the district were controlled (Kiesling, 1971).

MORE RECENT STUDIES—SOME FOCUSING ON COMPENSATORY EDUCATION

Even this brief recounting of findings of early studies indeed confirms the inconsistency noted in the quotation from Averch et al., (1972). The results of these early efforts to uncover connections among resources, costs, and student outcome were matched by the rather inconclusive early efforts to evaluate the effectiveness of the Title I program, itself. Studies carried out at both the national level and at the state level yielded ambiguous results. No national study, for example, demonstrated that any federal effort in CE was an unqualified success. Few, if any studies, on the other hand, claimed that all efforts at CE were irredeemable failures.

The evaluations of Title I did not provide strong evidence for the effectiveness of this large federal effort. The TEMPO study (Mosbaek, 1968), for example, reported mixed results in that some recipients appeared to have made some gains, but that others seemed clearly to have fallen further behind. However, the TEMPO study was conducted very early in the history of Title I—the first year and one-half of its operation.

Surveys of Title I initiated by USOE (e.g., DHEW, 1970; Glass, 1970) did not collect meaningful data on the cognitive impact of Title I for a sufficiently large or representative sample of students for an adequate assessment of the program's success. In an attempt to synthesize the Title I evaluation data collected from 1965 through 1970, Wargo, Tallmadge, Michaels, Lipe, and Morris (1972) concluded that " . . . nationally representative and valid impact data are simply not available . . . " A recent survey (Gamel, et al., 1975) reinforces this view of the inadequacy of data passed up from LEAs through the SEAs to DHEW. Gamel, et al., (1975, p. 18) reported that " . . . there were no identifiable trends toward more valid or consistent reporting practices across the years." McLaughlin (1977) makes the same criticism of the data in his synthesis of Title I studies from 1965-1975.

More recent studies have moved in the direction of overcoming some of the weaknesses in the design of previous studies. None of these more recent studies has managed to overcome all the problems associated with establishing resource/effectiveness relationships, but they are encouraging insofar as methodological advances appear to have been made in the study of them. These more recent studies have been performed, as is the case with the present research, as parts of larger evaluative studies of CE sponsored by state and federal authorities, or have been concerned with school and student populations similar to those of interest in this study.

In particular, resource/effectiveness studies by Summers and Wolfe (1974, 1975, 1977), Murname (1975), Kiesling (1972), Blaschke (1975) and the cost/effectiveness component of the Compensatory Reading Study (Flynn, Hass, and Al-Salam, 1976) indicate that it is possible

to overcome some of the problems encountered in earlier studies. The collection of at least some student-specific resource data (linking students to particular teachers) enabled Summers and Wolfe (1974, 1975), for example, to report that various aspects of class size, school size, and teacher characteristics (experience and background) are (or appear to be) helpful to learning on the part of identifiable sub-groups of students. For example, elementary students who are below grade level did better in classes of less than 28 students; other elementary students were not affected by class sizes of up to 34 students. The pattern of other results reported by Summers and Wolfe is similar in that resource inputs seem to have differential effects on sub-groups of students. This in itself may be an important outcome—the need to direct effort toward differential effects of resources as a function of student characteristics.

Kiesling (1972) attempted to estimate the amount of resources devoted to a particular skill area. He was concerned with resources used in the reading instructional program and not with the aggregate level of resources. Kiesling's results seem much more positive than the bulk of previous research. He found that the minutes of instruction by reading specialists was a significant variable in explaning educational outcome. There were, however, diminishing returns to investment in reading specialists. Kiesling's study is particularly important since it focused on CE programs (although in only one state, California). The sample consisted of 42 schools in 37 districts. Kiesling, however, concentrated his data collection on Title I projects. Such concentration necessarily neglects the contribution of regular school programs and other CE programs to increases in student achievement.

Murname (1975) was able to relate certain teacher characteristics—experience and sex, for example—to outcomes for sub-samples of students in a study in New Haven. He reports, quite interestingly, that the effectiveness of teachers increases dramatically in the first years of teaching, with a peak reached during the third to fifth year. The relationship between effectiveness and experience did not hold for teachers with more than five years of experience. Murname recommends collecting detailed information on individual teacher's instructional practices, as has been done in the SES.

A study by Blaschke (1975) received attention when it reported a positive correlation between the level of achievement and the cost of resources devoted to reading. The study made a significant step forward in methodology by trying to measure only resources devoted to reading rather than to total or to CE expenditure levels. The study sample consisted of 25 successful sites (school districts) and 23 unsuccessful sites. Blaschke's approach was to look for differences in school practices between the two types of sites. Blaschke concluded that the successful sites devote more resources to reading.

The time devoted to reading was translated into a dollar cost by Blaschke to form his measure of resource level. In the study year 1973-74, this measure of cost accounted for 30 percent of the variance in achievement scores. In the study year 1974-75, however, cost accounted for only nine percent of the variance. Thus, this study supplies some evidence that resources do make a difference.

Some flaws in the Blaschke study should be considered in assessing the validity of the results. First, there was only a very weak attempt to control for the effects of socioeconomic status on achievement gain. Second, different tests were used to measure achievement gain, and

some of the difference in gain between successful and unsuccessful schools could have been caused by the test taken rather than school treatment. A last problem concerns the cost analysis. Blaschke used the salary schedule at each district to calculate the prices paid for personnel. Therefore, we are not sure whether the level of cost associated with a reading program is due to the level of resources (time spent in reading) or to the price level in a district.

Flynn, Hass, and Al-Salam (1976) used much the same cost methodology to estimate the cost of resources used in compensatory reading programs. Flynn's work had the advantage that all students took the same test and he had access to better controls for socioeconomic status. Flynn also separated his analysis by grade in order to eliminate the scaling problem that could contaminate the research when test scores are averaged across grades, as was done in the Blaschke study. Additionally, Flynn used the 'resource' approach to cost analysis (Haggart, 1971 and 1978), where standard prices are applied to resource levels to estimate cost. This practice eliminates bias due to price level differences among districts.

Flynn concluded that there appeared to be no consistent relationship between the cost of a program and its apparent effectiveness as measured by achievement test scores. Flynn, tempered his conclusion, however, by stating that an inadequate measure of effectiveness (residual gain score in the presence of ceiling effects) could have prevented him from finding the relationship between cost and effectiveness.

In the results that have emerged from the large evaluation of the Emergency School Aid Act (ESAA) program, was the report of a positive finding with respect to the critical mass hypothesis. The critical mass idea presumes that some minimum level of expenditures is necessary to achieve positive returns to resource or dollar inputs. Coulson and his colleagues (Coulson, Ozenne, Bradford, Doherty, Duck, Hemenway, and Van Gelder, 1976) divided the sample into three groups according to the level of regular expenditures in the district. They found that the group receiving high district expenditures outperformed the other two groups. They also divided their sample into levels of CE funding, but found no relationship between the level of CE funding and achievement gain.

The investigators assert that their study provides evidence of the existence of a critical mass, which in itself would indicate a positive relationship between expenditures and achievement. The credibility of the finding was weakened when the analysis was repeated with data collected the following year (Coulson, et al., 1977). This second time they concluded that there was no evidence on total per-pupil funding to support the critical mass. However, the authors do report some positive associations, at the student level, between expenditures and achievement gain.

We should note that the notion of the critical mass has most frequently been posited in reference to incremental CE funding. In a study using data from the State of California, Dougharty and Klibanoff (1977) were unable to uncover any evidence in support of the critical mass hypothesis, either in terms of expenditures or concentration of CE personnel.

Recently, results from the ongoing evaluation of the Follow Through program have been issued. Although a cost analysis of the Follow Through models was performed (Rogers, et al., 1977), no cost or resource effectiveness analysis was undertaken. This was due, in part, to

the reality that the Follow Through models were not alternatives that could be compared on a cost-effectiveness basis.

The National Institute of Education, in accordance with the Education Amendments of 1974, conducted its own evaluation of Title I—independently of the research being pursued in the SES. Although, again, no cost/effectiveness results were reported (NIE, 1978) the results on services provided to Title I participants are consistent with the results of the resource analysis (Haggart, Klibanoff, Summer, and Williams, 1979) underlying this present research—that is, that Title I participants on average receive more educational services than do other students.

PROBLEMS AND PROPOSED REMEDIES

The funding of CE programs is based in part on the belief that there are positive associations between increased resource levels and student achievement. Taken as a whole, the results reviewed above do not provide strong support for the hypothesis. However, certain methodological problems can be identified as having possibly masked those relationships. By and large these problems reflect limitations of the data used to estimate the level and intensity of educational resources, together with an inadequate specification of the educational process. We will present these limitations under six headings: (1) Dollars as a Proxy for Resource Use, (2) Levels of Data Analysis, (3) Mismatch Between Input and Output Measures, (4) Regional Price Variation, (5) Data Analysis Method, and (6) Measures of Effectiveness.

Dollars as a Proxy for Resource Use

The variables used as measures of the resource input to educational programs in some studies have reflected the implicit assumption, as Tallmadge notes (1973), that the dollars spent are themselves the educational resource and treatment, rather than the more logical view that dollars purchase resources which are combined and used to accomplish educational ends. The inclusion of measures of the average teacher salary, or the number of books in the school library, for example, does not provide information on how such resources are combined into educational treatments. Nor do such measures tell us how much use students make of those resources. Even where detailed information on the resources available in the classroom has been collected (e.g., Flynn, Hass, and Al-Salam, 1976), the necessary information on actual resource use has been lacking.

This criticism implies that it is not only the level of resources that is important in determining gain, but also the way in which those resources are used. Recent work by Bloom (1974), Kiesling (1972), Wiley and Harnischfeger (1974), and the ESAA evaluation (Coulson et al., 1977) reaffirms the importance of measuring the resource mix.

In the SES, information was collected on the level and mix of educational resources that students receive. As described more fully later in this chapter, we estimate separately the cost of various types of instructional program components (e.g., small group instruction, tutoring, small group instruction by a reading specialist) in various instructional group sizes (e.g., individual, small, medium and large group instruction). These separate costs for program components can, of course, be readily summed to yield the cost of the resource mix or

combination to which a student is exposed. By approaching the problem in this manner, we realize a rather sensitive measure of the resources used in instruction.

Levels of Data Aggregation

Some previous studies have been concerned with *average* achievement as a function of *average* per-pupil resource expenditure (e.g., Coleman, et al., 1966; Cohn, 1968; Kiesling, 1969). The average achievement has been calculated at either the classroom, school, or district level; the average resource expenditure has been calculated at the district level. Such data aggregation can easily mask the effects of CE services if such services are concentrated on a relatively small segment of the district's or school's student population. It is necessary that both achievement and resources be measured at the student level in order to uncover any differential effects of resources.

With respect to this later point we may note the results of studies by Summers and Wolfe (1974, 1975, 1977) which indicate fairly significant variations in the effects of different resources as a function of student characteristics. Further, findings reported by Chalupsky, et al., (1972) reinforce the view that different resources have differential effects on different students, especially with respect to differences between upper and lower socioeconomic groups.

In the present study the costs of a *student's* reading and math instruction are the primary units of analysis. We are able to assess the relative costs and effects of various resource combinations (treatments). In addition to these individual student-level programs, we also have the capability to aggregate costs for analyses at the school level or the program level.

Mismatch Between Input and Output Measures

An additional difficulty present in the design of other studies is that achievement scores measure ability in one area, yet the measure of resource consumption most typically used in the early studies is the expenditure per average daily attendance, a measure of the total cost of running the educational plant (Burkhead, et al.). By using this measure, it is implicitly assumed that each school spends the same proportion of resources on each cognitive skill over all levels of expenditures. Moreover, many studies include an expenditure-per-student for components of the school program. For example, per-pupil expenditure for textbooks (Burkhead, et al., 1967; Kiesling, 1969) or instructional expenditures per pupil (Coleman, et al., 1966; Smith, 1972) have been included. However, such categories are still quite mismatched to the outcome measures employed—achievement in one or two skill areas.

In the SES we use only those categories of costs related exclusively to a student's reading and math program in examining the relationships between costs and outcomes. In adopting the resource approach to estimating the cost of programs, we prefer not to enter ambiguous costs into the equations estimating the relationship between costs and outcomes. In this context, an ambiguous cost is the cost of any resource input that cannot be directly related and apportioned to either reading or math instruction. Hence, even total instructional costs per pupil, for example, would represent an overestimate of resource inputs when the measure-

ment of outcome is restricted to limited areas (e.g., reading or math achievement). A more detailed description of the cost analysis method to be employed in this study is presented later.

Regional Price Variation

Relationships in large-scale studies of the cost/effectiveness of instructional programs can be masked by a failure to correct district expenditures for price level distortions (Benson, et al., 1965, Blaschke, 1975). Standardized prices for comparable resources are employed in this study in order to avoid errors resulting from such distortions.

Data Analysis Method

Many of the studies concerned with evaluating CE have been concerned simply with the question of whether a funding program (e.g., Title I) makes a difference in educational outcome. That is, they have compared students receiving CE services (the treatment group) with those who do not (the control group), using analysis-of-variance techniques. Now, while it is true that such techniques may be able to establish that CE does (or does not) make a difference, they fall short of addressing the broader analytic purposes of cost/effectiveness analysis.

For our study, we employ multiple-regression analysis which (like analysis-of-variance) is also a variant of the general linear model, but which leads more directly to estimates of changes in outcome associated with changes in cost. This approach will enable us to assess the importance of various resource variables in affecting educational outcomes. Moreover, our choice seems appropriate since regression-analysis procedures have provided the most positive results to date in the various studies of the cost and effectiveness of educational programs (Kiesling, 1972; Summers and Wolfe, 1975; Murname, 1975).

Measures of Effectiveness

The measures of effectiveness used in previous studies have, by and large, been inadequate to the task of resource/effectiveness analysis. The data used in the EEOS Report, and in its many reanalyses, were measures of verbal ability rather than of achievement. Other studies (Dougharty and Klibanoff, 1977) have had to rely on existing district-level or state-level data that require the merging of results from different tests prior to analysis. This can result in rather imprecise assessments of achievement. The use of grade-equivalent representations of achievement has been common among earlier studies and is fraught with the treatment of artifactual results, as noted by Tallmadge and Horst (1976).

Even in studies that have been sensitive to the extreme difficulty in adequately measuring student achievement—and that have collected data as a part of the study—the outcome measures have presented difficulties. This was the case in the analysis reported by Flynn, Hass, and Al-Salam (1976), in which the authors concluded that the non-constant posttest variance for classes at different pretest levels " . . . may have masked any meaningful relationships", (p. 109).

In the SES, a carefully selected test instrument provides the basis of our measure of effective-

ness. The CTBS was subjected to both statistical and judgmental debiasing efforts to mitigate the effects of cultural or ethnic bias in the instrument. Further, empirical fall and spring norms were developed on the basis of the study's large **Representative Sample.** The resulting test scores, used in our analysis, are new vertical scale scores that readily allow the combination of data from different levels of the test.

This latter point is important since each student in the study was tested with both the publisher's recommended level of the test and the test level immediately below. This allowed the development of an algorithm for identifying the best level of the test instrument for each grade in each school. The use of these recommended levels enabled us to avoid much of the difficulty associated with floor and ceiling effects.

To summarize this chapter, the research that bears on resources and educational outcomes has been extensive, but we find that certain features of the research designs employed may have clouded the detection of relationships. These features have to do with (1) use of dollars as a proxy for resource use, (2) levels of data aggregation, (3) mismatch between input and output measures, (4) regional price variation, (5) data analysis method, and (6) measures of effectiveness. Our study plan was designed to overcome these features, or at least reduce their effects.

CHAPTER 3. APPROACH OF THE STUDY

In this study, we have addressed the problems identified in our review of past studies primarily by using each student's exposure to resources as the basis for estimating cost. After discussing the relevant details of this basis, we describe the general analysis strategies, then conclude the chapter with the results obtained from an analysis of the full SES sample within grades.

BASIS FOR ESTIMATING COST

The method for estimating cost was designed to provide a dollar-metric that reflects exposure to resources, accommodates regional price differences, and is sensitive in discerning intra-classroom differences among instructional programs. The dollar-metric, expressed as standard resource dollars (SRDs), permits cost comparisons among instructional programs on an equitable basis. The comparability needed for this study is achieved by using the same price, or cost per use, for comparable resources or mixes of resources. It is along this comparability dimension that our analysis of cost differs from the more traditional cost analysis, where the focus is on analyzing the cost, *per se*. The major facets that collectively set our approach apart are described in the following paragraphs.

Resource Quantities as Measures

The data obtained from the SES questionnaires describe instructional programs in terms of resource quantities used rather than dollar values. Where resources must be prorated among several students, or where identical kinds of resources (teacher hours for individual instruction and prorated teacher hours for group instruction, etc.) must be aggregated for a particular student, the metric again is 'resource quantities,' not dollar values. Dollar values are assigned to a student's instructional program only after the kinds and quantities of resources utilized in his program have been completely specified. This strategy reduces some of the measurement difficulties associated with the use of dollars as proxies for resource use at the individual student level. In particular, this approach allows the analyses to reflect differences in resource levels utilized *and* differences in the ways resources are used.

Bottom-Up Cost Calculation

In the cost model, the quantity of each type of resource is determined separately for each student's instructional program, then resources are aggregated and priced to obtain a total cost for each student's use of the resources. This contrasts to the more common top-down approach that begins with total resources (often in dollars) and then prorates those resources or dollars among students. The bottom-up approach substantially overcomes the problem arising from the implicit assumption underlying the simple proration of total resources—that all students share alike in the use of resources.

Measurement of Resource Exposure

The SES data collection instruments were designed to measure the resources offered to students in their reading and math instruction; that is, the items measure the resource-use and

the exposure of the student to those resources. In developing the estimates for the analyses of this report, each student's attendance is used as a basis for the cost of services actually *received*. We therefore use the student's actual resource-use, or *exposure*. The results are different from those that would be obtained by dividing dollar expenditures for resources by the number of students. To be sure, it is theoretically possible that for some categories of resource the measures may be equivalent. But, as noted, this would be the case only where the students share equally in the use of a particular resource.

Relevant Costs

In the SES, the analysis is designed to identify the differential resources used in providing instruction to various categories of students. The costs we calculate, therefore, are only for those resources that differentiate one student's instructional program from another's. Hence, resources that are commonly used in providing instruction to all students are not included; for example, we do not include costs of typical classroom space, furniture, general supplies, operation, and administration.

The Use of Total Variable Resources

In typical applications of resource/cost analysis, where the intent is to estimate the marginal cost (or additional expenditures) necessary to implement a particular educational program at a particular site, the bottom-line cost estimates usually represent *net* resource requirements. Resources that are already on hand and that will require no additional expenditure are excluded from the cost calculations. In the SES, where the object is to make simple dollar-metric comparisons of CE instructional practices (the distinguishing feature among programs) the *total* variable resource requirements are the more appropriate basis for cost calculations.

Comparable Costs Obtained Through Standard Prices

Keeping with the spirit of the above paragraph, we translate total variable resource requirements into estimates of comparable cost by using standard prices rather than district-specific prices. For comparing various instructional programs, the cost figures should reflect differences in the quantities and qualities of resources used to achieve educational outcomes. Comparisons of costs based on site-specific prices tend to obscure the very differences we seek to reveal.

Also, our estimation of cost for these analyses has been designed to identify more closely the amount rather than the quality of resources. In particular, the use of a constant salary for all teachers removes an unfounded expectation that the use of a more experienced teacher will necessarily produce greater achievement gains. This expectation may be true but our analyses are not designed to prove or disprove it.

(*Caveat:* It is important to remember that our cost figures are not the same as expenditures, nor are they 'costs' in the usual economic sense. Rather, they are a very special dollar-metric designed to measure a student's resource exposure. The metric is based on the application of standard prices to comparable resources, with the resulting cost being identified in terms

of standard resource dollars (SRDs). Also, the metric measures only relevant instructional resources, excluding resources common to the operation of most school systems.)

ANALYSIS STRATEGIES

In general, the analyses were designed to provide two avenues for examining cost and effectiveness. The first avenue is by means of multiple displays of average costs and achievement scores for various ways of subsetting the student sample; this might be termed a cost/gain reporting approach. The second avenue is to postulate regression models that relate achievement gain to cost, calculate estimates of the regression coefficients for cost, and then let the estimated coefficients serve as indices of cost-effectiveness.

Cost/Gain Reporting

Mean cost and achievement scores were calculated for a wide variety of subsets, or blocks, of the SES sample, where doing so was of policy interest, or where it was suspected that the cost-effectiveness relationships may differ distinctly from subset to subset. In the latter case, analyses across the entire sample may obscure relationships. Blocking by grade level was standard; the various relationships were expected to be different from grade to grade. Other blocking variables were employed within grade levels. The most important were CE selection category, instructional configuration, and achievement level. Other blocking variables included participation in free or reduced lunch programs (reading or math) program cost, and the joint blocking of school-average program costs and school-average achievement. The results of the later blocking were particularly unfruitful, and will not be reported. The various blocking arrangements will be described in detail in Chapter 4, along with the respective results of the analysis.

Costs and gains for reading and math for the students in the entire SES sample are shown in Table 3-1.

Table 3-1

Achievement Data and Total Program Cost, by Grade, for the Entire SES Sample of Students

	Grade	Achievement Data			Program Cost	Number of Students
		Pretest	Posttest	Raw Gain		
Reading	1	344	409	65	341	16,588
	2	416	459	43	331	15,071
	3	460	494	34	285	14,852
	4	493	523	30	232	14,934
	5	524	551	27	210	15,555
	6	556	581	25	185	18,086
Math	1	331	392	61	137	16,588
	2	393	448	55	143	15,091
	3	443	501	58	146	14,911
	4	495	545	50	148	14,972
	5	540	584	44	152	15,644
	6	582	623	41	138	17,885

Similar statistics for various subsets of the SES sample will be discussed at length in Chapter 4.

Index of Cost-Effectiveness

The general approach for this aspect of the analysis was to specify the functional form and variables for a model, or set of models, that reflects changes in student educational outcomes that can be associated with differences in resources used (as measured by the cost estimates of the RCM). The raw regression coefficients of the models were evaluated for various subsets of the SES sample using least-squares regression analysis. The point was to obtain stable and relatively unbiased estimates of the coefficients of the resource variables. Such coefficients provide comparable indices of cost-effectiveness because the units of measure for all resource variables are the same: standard resource dollars.

The coefficients (in linear models) provide a direct indication of the amount of effectiveness (i.e., growth in the dependent variables) that can be associated with a unit change in the respective resource category; large positive coefficients indicate high cost-effectiveness, and small coefficients indicate low cost-effectiveness.

Regression Models. Since there is no noncontroversial way of specifying achievement growth variables for a regression model, we initially pursued three approaches, taking comfort in the recommendation for multiple analyses made by Gilbert, Mosteller, and Tukey (1974) in a somewhat different context:

> The best we know how to do in such a situation is to seek out alternative methods of fallible inference, use up to several of them, and then, recognizing their fallibility, trust moderately in their combined message. (p. 156)

Our favored approach was simply to specify the posttest score as the dependent variable, and the pretest score as an independent variable. This approach is also recommended by others, for example, Linn and Slinde (1977). Another approach was to specify the residual gain score as the dependent variable. The residual gain score is computed as the difference between the actual posttest score and the expected postest score. The estimators for the expected post-test scores—derived from a least-squares regression of posttest on pretest across the entire sample within each grade—are of the form:

$$E(\text{posttest}) = \text{constant} + B(\text{pretest})$$

The coefficients for the estimators of expected posttest are as follows:

	Reading		Math	
Grade	Constant	B	Constant	B
1	103.1	.887	124.9	.809
2	82.3	.905	116.4	.846
3	105.2	.844	147.4	.800
4	92.1	.873	118.7	.865
5	50.1	.956	96.7	.900
6	72.2	.914	91.8	.911

A third approach was to use simple gain scores, which are calculated as the difference between posttest and pretest scores. Accordingly, at least six models were initially specified for each of the six grade levels, and for most of the blocking arrangements listed earlier. For reading:

Posttest

CTBS posttest = f(reading total program cost) + g(CTBS pretest) + error

CTBS posttest = f(10 reading program component costs) + g(CTBS pretest) + error

Raw Gain

CTBS posttest − CTBS pretest = f(reading total program cost) + error

CTBS posttest − CTBS pretest = f(10 reading program component costs) + error

Residual Gain

CTBS posttest — Expected CTBS posttest = f(reading total program cost) + error

CTBS posttest — Expected CTBS posttest = f(10 reading program component costs) + error

The f( ) are linear combinations of first and second order terms for each of the indicated total program cost or program component cost variables. We specified cost and pretest variables in both first and second order terms *a priori* to allow diminishing returns to be manifested in the models. In almost all cases, the addition of the second order terms failed to improve the fit of the models as judged by coefficients of determination (R^2). Parallel models were specified for math. For the affective domain, a posttest measure (for reading) was modeled as follows:

Student affective posttest score = f(reading total program cost)
+ g(affective pretest score) + error

Table 3-2 presents the raw regression coefficients for total program cost that were obtained by applying these models to the entire SES sample:

With few exceptions, the regression coefficients are negative and so small as to account for only trivial amounts of variation in outcome. Inspection of the simple correlations of program cost and achievement scores at both test occasions helps to explain why this is so. These correlation coefficients are shown in Table 3-3:

Program cost displays weakly negative associations with pretest achievement at each grade level, suggesting that, *for the sample as a whole,* more costly treatments tend to be allocated to students who are relatively more needy. Given that this is true, only strong positive correlations of cost to *posttest* scores would have led to positive regression coefficients for

Table 3-2

Regression Coefficients for Program Cost, by Grade

	Grade					
	1	2	3	4	5	6
Reading						
Posttest model	−.007	−.011	−.013	−.017	−.013	−.004
Raw gain model	−.005	−.002	−.003	−.004	−.004	−.009
Residual gain model	−.007	−.008	−.014	−.017	−.011	−.007
Math						
Posttest model	−.001	−.022	−.047	−.009	−.021	−.005
Raw gain model	−.010	−.006	−.030	−.013	−.007	−.010
Residual gain model	−.002	−.018	−.049	−.007	−.020	−.005
Affective (reading cost)						
Posttest model	N/A	.002	.003	.003	.006	.011

Table 3-3

Simple Correlations Among Total Program Cost, Pretest Scores and Posttest Score, by Grade

	Grade					
	1	2	3	4	5	6
Reading						
Cost with pretest	−.09	−.18	−.30	−.35	−.30	−.31
Pretest with posttest	.66	.80	.84	.85	.90	.90
Cost with posttest	−.08	−.18	−.28	−.33	−.29	−.29
Math						
Cost with pretest	−.15	−.15	−.16	−.22	−.20	−.20
Pretest with posttest	.63	.72	.72	.78	.79	.82
Cost with posttest	−.10	−.14	−.18	−.18	−.19	−.17
Affective						
Reading cost with pretest	N/A	−.03	−.02	−.10	−.03	.13

the resource variable. This does not happen, of course; posttest and pretest are highly correlated, and cost displays a weakly negative correlation with posttest.

The shapes of the relationships of cost to pretest and cost to posttest were examined by calculating the average total reading (and math) cost for five-precentile intervals (i.e., vigitiles) of the respective tests. The average costs decrease slightly as vigitiles increase, but more so in the upper grades. When plotted in sequence according to vigitile, there is a slight convexity toward the origin; again, the convexity is more pronounced in the upper grades. Within each grade, the pretest and posttest plots are almost congruent. General tests of linearity revealed in all cases that, although the non-linear trends were statistically significant, the linear effects explain the bulk of the between-vigitile variance. The proportions of variance explained by non-linear effects are typically less than half of what is explained by linear effects.

Specification Bias. We did not posit a *structural* model (i.e., one that attempts to capture even the major cause-effect relationships that exist in the education context) because we have a more narrow interest in determining how strongly our resource metric associates with variation in the outcome measures. Keeping things simple, we did not wish to specify the non-resource contextual variables (pupil characteristics, peer characteristics, district characteristics, etc.) into the models unless doing so would somehow improve the estimation of the regression coefficients for the resource variables.

On the other hand, we were aware that coefficients in a simple model that specifies only the resource (and pretest) variables may actually reflect some of the effects of the unspecified non-resource variables as well as the resource variables if the two types of variables are correlated. One of our early tasks, therefore, was to compute measures of association between the resource variables and representatives from each of four families of non-resource variables:

Student Scholastic Characteristics
Student Socioeconomic Status
Peer Characteristics
School/District Characteristics

The ranges of the association measures for reading for each grade level are presented in Table 3-4.

Table 3-4

Minimum and Maximum Measures of Association* Between Total Reading Program Cost and Non-Resource Variables

Type of Non-Resource Variable	Number of Indicator Variables	Grade 1	2	3	4	5	6
Student Scholastic Characteristics	7	.01/.17	.00/.18	−.02/.18	−.01/.13	.03/.15	.01/.18
Student Socioeconomic Status	4	−.03/.13	−.05/.05	−.05/.13	−.16/.20	−.13/.21	−.14/.29
Peer Characteristics	4	−.10/.05	−.00/.17	.10/.12	.18/.20	.19/.23	.22/.29
School/District Characteristics	9	−.07/.24	−.05/.32	.00/.25	.03/.31	.03/.31	−.04/.33
	24						

*Pearson's r for continuous variables, Eta for nominal variables.

None of the measures of association calculated were very strong. Accordingly, we tentatively assumed that the regression coefficients for resource variables that were estimated in our models are not greatly affected by non-specified, non-resource variables.

We explored this assumption further by performing stepwise regression procedures for grades 2 and 5. Specifically, a series of regression analyses were conducted, beginning with the regression of posttest upon cost and pretest. One additional non-resource variable was added

into the explanatory scale of the model for each succeding regression; the particular variable added was the one which at that point 'explained' the largest amount of residual variance. Twenty-four non-resource variables were added in this fashion. If the calculated regression coefficients for cost were to change substantially in successive regressions, specification bias would be indicated. As it turned out, the coefficients for cost were only slightly affected, as shown below in the results for reading:

	Number of Additional Non-Resource Variables in Model			
	None	Two	Fourteen	Twenty-four
Grade 2	-.009	-.010	-.014	-.013
Grade 5	-.014	-.011	-.009	-.009

Specification of Cost Variables. The specification of cost as a single variable in the regression models is a convenience, because the associated regression coefficient provides a simple measure of returns to investment in educational resources. This modeling implicitly assumes that the returns are equal for different ways of deploying resources. Accordingly, some of the analyses use models that specify cost as ten separate variables—the ten program components mentioned in Chapter 1. Each of the program components represents a different pattern of deployment of instructional staff, plus the associated materials and equipment. A program component *cost* is an assignment of cost to a student for instruction received within that component. The program components are listed below:

1. Classroom Teacher—Whole Class
2. Classroom Teacher—Large Group
3. Classroom Teacher—Medium Group
4. Classroom Teacher—Small Group
5. Teaching Assistant/Aide
6. Special Teacher—Medium Group
7. Special Teacher—Small Group
8. Tutoring by Student/Volunteer
9. Independent Study—Program Materials
10. Independent Study

Substitution of program component costs for total cost in the posttest regression model only minimally improves the multiple correlation, when the model is applied to the SES sample as a whole. This is apparent from the R^2 values in Table 3-5.

Table 3-6 presents the estimated raw regression coefficients for the posttest model, where the ten component costs are specified. The interpretation given to the data should be purely descriptive. For example, in our sample of students, special-teacher instruction is associated with low achievement, other things being equal; that is, the special-teacher components obtain negative regression coefficients. However, this result may simply reflect the reality that lower achieving students are generally targeted for instruction by special teachers.

The failure to find a nontrivial relationship between cost and outcome was not too disappointing, for it was initially felt that these results were an artifact of pooling data for subsets of students who were different in ways germane to the cost-effectiveness question. The examination of costs and outcomes within these subsets is the subject of Chapter 4. Because the results for the models (Table 3-2) are so similar, Chapter 4 is limited to the posttest model for the most part. The residual gain model is used for a few special analyses.

Table 3-5

Total Regression R^2 for Posttest Versus Pretest, and Alternative Specifications of Cost

	Grade					
	1	2	3	4	5	6
Reading						
Total cost specified	.43	.63	.71	.74	.79	.81
Component costs Specified	.45	.64	.71	.74	.80	.81
Math						
Total cost specified	.43	.51	.53	.62	.64	.66
Component costs Specified	.43	.51	.53.	.62	.64	.67

Table 3-6

Regression Coefficients for the Cost of Reading and Math Program Components by Grade*

	READING					
	Grade					
	1	2	3	4	5	6
Program Component						
Classroom Teacher—Whole Class	.028	(–.001)	–.029	(.006)	.038	.021
Classroom Teacher—Large Group	.058	.026	.029	(–.006)	(.004)	(.006)
Classroom Teacher—Medium Group	.048	.016	(–.004)	(–.002)	(.001)	(.014)
Classroom Teacher—Small Group	(.004)	–.004	–.009	–.011	(.004)	(–.001)
Teaching Assistant/Aide	–.049	–.051	–.069	(–.024)	–.098	–.061
Special Teacher—Medium Group	(.008)	–.047	–.036	–.039	–.027	–.030
Special Teacher—Small Group	–.047	–.026	–.019	–.026	–.022	–.010
Tutoring by Student/Volunteer	(–.023)	(–.062)	(–.030)	.198	(.063)	(.030)
Independent Study—Program Materials	.099	.070	(.033)	–.059	(–.002)	(.025)
Independent Study	.084	.030	(.052)	–.027	(–.016)	.035
Pretest Score Coefficient	.866	.819	.843	.866	.931	.925
Constant	102	117	107	97	63	65

Table 3-6 (Continued)

	MATH Grade 1	2	3	4	5	6
Program Component						
Classroom Teacher—Whole Class	(.016)	.064	.035	.055	.099	.040
Classroom Teacher—Large Group	.037	.027	(.007)	(.013)	(.037)	(.036)
Classroom Teacher—Medium Group	.036	(−.006)	−.045	−.028	(−.016)	.030
Classroom Teacher—Small Group	−.008	(−.009)	−.039	(.007)	(−.003)	(−.001)
Teaching Assistant/Aide	−.068	−.170	−.224	(−.036)	−.082	−.125
Special Teacher—Medium Group	(−.025)	(−.017)	−.096	(.031)	(−.033)	(−.019)
Special Teacher—Small Group	(−.014)	−.023	(−.009)	(−.013)	−.017	(−.012)
Tutoring by Student/Volunteer	−.666	−.203	−.684	(−.203)	−.620	(−.350)
Independent Study—Program Materials	.579	−.102	.151	−.120	.125	−.072
Independent Study	.141	(.013)	.142	.135	.131	.100
Pretest Score Coefficient	.818	.797	.813	.849	.893	.902
Constant	117	134	139	120	96	93

*Values in parentheses are less than twice their respective standard errors.

CHAPTER 4. RESULTS OF ANALYSES

This chapter documents analyses of costs and effectiveness under several blocking schemes; the most important for purposes of this report is blocking by CE selection status. In the analyses that are reported, the cost/gain reporting approach is predominant. The cost-effectiveness index approach produced rather disappointing results: the coefficients representing the association of program cost to achievement outcome were frequently negative and always so small as to account for only trivial proportions of the variations in outcome. Alternative interpretations of this general result will be discussed.

The first part of this chapter is devoted to analyses with blockings that correspond to CE selection categories. This is followed by analyses of blocking by achievement levels and by participation in lunch programs. Then, there is an analysis of students with unexpectedly high and low gains, and an analysis of students stratified according to level of program cost. Finally, there is an analysis of instructional configurations. Presentations for reading and math are interspersed.

COST-EFFECTIVENESS BY CE SELECTION CATEGORY

Blocking by CE selection category was necessary to address the question of whether source of funding—in particular, whether or not Title I funding has an independent effect on educational outcome. It was also pertinent to determine whether *compensatory* education is more cost-effective for some grade levels than for others. This blocking occurs with six levels:

Title I students in Title I schools
Other-CE students in Title I schools
Other-CE students in Other-CE schools
Non-CE students in Title I schools
Non-CE students in Other-CE schools
Non-CE students in non-CE schools

For other analyses, the six CE selection categories were collapsed into three groups by student selection status only—Title I, Other-CE and non-CE students. For some analyses, special subsets of the "non-CE students in non-CE schools" group were isolated to serve as comparison groups for the Title I students.

Summary data for achievement scores and individual reading and math program cost are presented in Tables 4-1 and 4-2. The data are organized by the six CE selection categories within grade.

Data are also presented for two comparison groups. Comparison Group A consists of non-CE students in non-CE schools who were identified by teachers as being in need of CE services. Comparison Group B consists of students from Comparison Group A who ranked at or below the 33rd percentile on pretest. The performance of the comparison students is generally meant to represent what one would expect from Title I students if the Title I services were not available. Although the comparison groups are relatively small, they represent students from

Table 4-1

Reading Program Cost and Achievement Data, by Grade, and by CE Selection Status

CE Status / Students/School	Achievement Data				Program Cost		Number of Students
	Pretest	Posttest	Raw Gain	% Gain	Mean Cost	Cost/Gain	
Grade 1							
Title I/Title I	324	383	59	18	416	7	2,743
Other-CE/Title I	337	397	60	18	378	6	970
Other-CE/Other-CE	336	391	55	16	405	7	551
Non-CE/Title I	349	416	67	19	325	5	7,075
Non-CE/Other-CE	358	424	66	18	314	5	3,146
Non-CE/Non-CE	342	409	67	20	302	5	2,103
Comparison Group-A	321	375	54	17	330	6	520
Comparison Group-B	312	366	54	17	329	6	275
Grade 2							
Title I/Title I	381	424	43	11	420	10	2,923
Other-CE/Title I	405	447	42	10	367	9	883
Other-CE/Other-CE	388	434	46	12	405	9	696
Non-CE/Title I	427	470	43	10	311	7	5,873
Non-CE/Other-CE	442	485	43	10	290	7	2,799
Non-CE/Non-CE	413	456	43	10	275	6	1,897
Comparison Group-A	377	416	39	10	292	7	665
Comparison Group-B	365	405	41	11	302	7	477
Grade 3							
Title I/Title I	415	451	36	9	378	11	2,861
Other-CE/Title I	443	475	32	7	346	11	822
Other-CE/Other-CE	428	462	34	8	370	11	612
Non-CE/Title I	475	507	32	7	255	8	5,797
Non-CE/Other-CE	487	522	35	7	242	7	2,864
Non-CE/Non-CE	462	496	34	7	249	7	1,896
Comparison Group-A	415	446	31	8	298	10	561
Comparison Group-B	404	438	35	9	298	9	401

Table 4–1 (Continued)

Grade 4							
Title I/Title I	439	471	32	7	359	11	2,306
Other-CE/Title I	463	492	29	6	311	11	776
Other-CE/Other-CE	455	485	30	7	319	11	602
Non-CE/Title I	506	536	30	6	202	7	6,274
Non-CE/Other-CE	520	549	29	6	183	6	3,109
Non-CE/Non-CE	495	525	30	6	192	6	1,867
Comparison Group-A	442	473	30	7	246	8	584
Comparison Group-B	428	459	31	7	259	8	408
Grade 5							
Title I/Title I	466	491	25	5	322	13	2,069
Other-CE/Title I	492	516	24	5	277	12	675
Other-CE/Other-CE	479	506	27	6	294	11	573
Non-CE/Title I	536	563	27	5	188	7	6,564
Non-CE/Other-CE	546	575	29	5	167	6	3,531
Non-CE/Non-CE	527	555	28	5	195	7	2,143
Comparison Group-A	463	486	23	5	223	10	518
Comparison Group-B	449	474	25	6	228	9	426
Grade 6							
Title I/Title I	489	515	26	5	319	12	1,894
Other-CE/Title I	523	550	27	5	234	9	792
Other-CE/Other-CE	498	519	21	4	261	12	600
Non-CE/Title I	568	594	26	5	162	6	6,726
Non-CE/Other-CE	576	600	24	4	162	7	5,621
Non-CE/Non-CE	554	579	25	5	165	7	2,453
Comparison Group-A	494	519	25	5	204	8	660
Comparison Group-B	474	501	27	6	215	8	478

Table 4-2

Math Program Cost and Achievement Data, by Grade, and by CE Selection Status

CE Status	Achievement Data				Program Cost		Number of
Students/School	Pretest	Posttest	Raw Gain	% Gain	Mean Cost	Cost/Gain	Students
Grade 1							
Title I/Title I	309	371	62	20	209	3	1,553
Other-CE/Title I	326	383	57	18	144	3	842
Other-CE/Other-CE	325	388	63	19	190	3	326
Non-CE/Title I	332	395	63	19	132	2	8,403
Non-CE/Other-CE	341	402	61	18	116	2	3,378
Non-CE/Non-CE	331	389	58	18	128	2	2,086
Comparison Group-A	308	357	49	16	142	3	515
Comparison Group-B	299	345	45	15	145	3	324
Grade 2							
Title I/Title I	363	417	54	15	212	4	1,585
Other-CE/Title I	387	441	54	14	141	3	734
Other-CE/Other-CE	380	434	54	14	197	4	286
Non-CE/Title I	395	451	56	14	140	3	7,383
Non-CE/Other-CE	407	464	57	14	120	2	3,217
Non-CE/Non-CE	390	443	53	14	132	2	1,886
Comparison Group-A	365	410	45	12	145	3	662
Comparison Group-B	346	391	45	13	146	3	408
Grade 3							
Title I/Title I	407	463	56	14	217	4	1,681
Other-CE/Title I	431	486	55	13	174	3	669
Other-CE/Other-CE	424	470	46	11	204	4	353
Non-CE/Title I	447	505	58	13	134	2	7,166
Non-CE/Other-CE	459	520	61	13	127	2	3,154
Non-CE/Non-CE	443	502	59	13	138	2	1,888
Comparison Group-A	410	460	50	12	167	3	560
Comparison Group-B	395	446	51	13	169	3	394

Table 4-2 (Continued)

Grade 4							
Title I/Title I	445	499	54	12	239	4	1,392
Other-CE/Title I	475	523	48	10	196	4	740
Other-CE/Other-CE	467	500	33	7	211	6	363
Non-CE/Title I	500	551	51	10	139	3	7,254
Non-CE/Other-CE	512	563	51	10	121	2	3,341
Non-CE/Non-CE	497	546	49	10	136	3	1,882
Comparison Group-A	456	505	49	11	160	3	597
Comparison Group-B	437	485	48	11	166	3	368
Grade 5							
Title I/Title I	487	532	45	9	266	6	1,247
Other-CE/Title I	520	558	38	7	194	5	645
Other-CE/Other-CE	496	538	42	9	200	5	388
Non-CE/Title I	544	587	43	8	141	3	7,468
Non-CE/Other-CE	556	603	47	9	126	3	3,725
Non-CE/Non-CE	541	587	46	9	144	3	2,171
Comparison Group-A	487	524	37	8	153	4	524
Comparison Group-B	463	502	39	8	155	4	371
Grade 6							
Title I/Title I	527	571	44	8	246	6	1,094
Other-CE/Title I	552	592	40	7	172	4	808
Other-CE/Other-CE	526	562	36	7	180	5	437
Non-CE/Title I	585	626	41	7	133	3	7,474
Non-CE/Other-CE	597	637	40	7	118	3	5,615
Non-CE/Non-CE	584	623	39	7	135	3	2,457
Comparison Group-A	533	567	33	6	153	5	659
Comparison Group-B	512	544	32	6	154	5	442

forty schools around the country. Average pretest scores are fairly close to those for Title I students.

In all grades, the Title I students are provided with the most expensive reading and math programs. Students receiving programs funded by either Title I or Other-CE sources have average program costs substantially higher than students receiving non-compensatory, or regular instruction. The most striking observation is that, regardless of CE selection status, the raw gain within grade is approximately the same for all categories, except for a slight difference in the first grade. In percentage terms, the achievement gains for CE students are about the same or higher than for non-CE students. As can also be seen from the data, the mean program cost is usually higher for categories with lower average pretest scores.

From a purely descriptive perspective, the simple measure of cost-per-unit of gain is higher for CE students; that is more evident in reading than in math. The cost-per unit of gain for reading programs ranged from $9 to $13 for CE students and from $5 to $8 for non-CE students, with a distinct break between the two groups of students within each grade. For math, the ranges are much lower—$3 to $6 for CE students; $2 to $5 for non-CE students —with the difference between the two groups of students being less but still discernible. The CE students tend to perform better on achievement than do both comparison groups, but the cost per unit of gain is also higher.

Although Tables 4-1 and 4-2 illuminate the joint behavior of costs and achievement, we have resisted seeking the statistical significance of differences in gain or posttest scores among the CE selection categories within or over grades. This is quite by design. The focus of our analysis is on the independent relationship of resource utilization (as measured by our cost variables) with student achievement, but not on the net performance characteristics of various CE programs. Although the difference may appear to be obscure, we believe it goes beyond a mere preference.

To elaborate, it is clear in the data of Tables 4-1 and 4-2 that large, pre-existing differences in student achievement exist among the six selection categories. In particular, Title I students begin each academic year substantially behind their non-CE classmates; in fact, they also begin with lower test scores than do students participating in other compensatory programs. Yet, we see that absolute magnitudes of the gain scores are similar. It is also clear from the two tables (4-1 and 4-2) that CE students, and most notably Title I students, receive more intensive and costly instructional treatments. Hence, there is an obvious negative relationship between initial test status and the program cost.

Given the essential non-equivalence of the CE groups based on their pretests, it can be argued persuasively that the comparison of change scores among the categories is both dangerous and errorful. Would an analysis-of-variance over the gain scores tell us much in addition to what is clear from the tabled means themselves? We believe not, for the essential conundrum would remain. CE students both begin and end each school year behind their non-CE classmates, yet they gain about as much during each year. The comparison groups provide some relief in that there is more equivalence with Title I on pretest scores; but again, we recommend cautious interpretations because the comparison groups may be non-equivalent with Title I students along unmeasured characteristics.

Figures 4-1 and 4-2 provide graphic representation of some of the data in Tables 4-1 and 4-2. Reading program cost is measured along the horizontal axis and achievement test scores (pretest and posttest) are measured along the vertical axis. Average pretest and posttest scores for each grouping are plotted against average program cost, and a vertical line joins the pretest and posttest points. Achievement data and costs are plotted in this manner for the six CE selection categories (from Tables 4-1 and 4-2) and for the total sample.

For both reading and math the relative placement of the vertical lines is very consistent from grade level to grade level. A pattern emerges in the upper grades, where there is a more definite separation between CE and non-CE categories, and a more definite inverse relationship between cost and achievement levels. The latter tendency may reflect the more precise placement practices that are possible at the higher grades. Again, Title I students consistently have the lowest achievement status on average, and their reading costs are consistently highest.

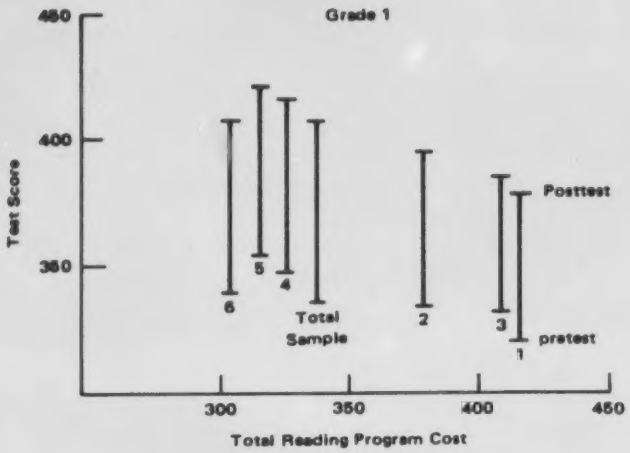
Regression analyses were performed on the data from each of the six CE selection categories using the models described in Chapter 3. The results did not differ greatly from those for the total sample displayed in Table 3-2. The raw regression coefficients in all cases were so small as to indicate that the associations of cost with educational outcome are trivial for those subsamples. Also, the regression coefficients were negative in most cases.

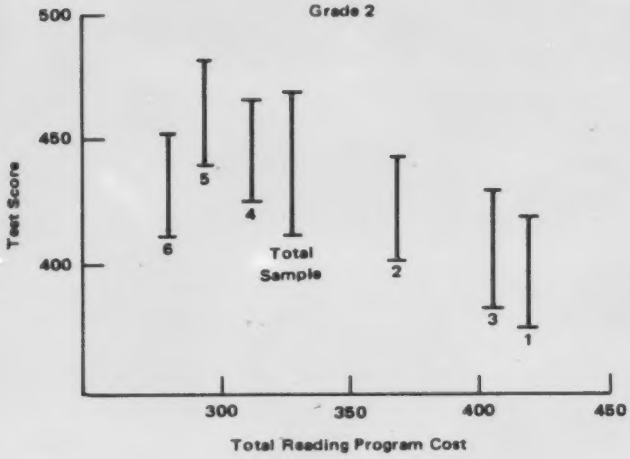
Tables 4-3 and 4-4 present reading and math regression coefficients for program components from regression analyses within categories of CE selection status. In these tables, the program components have been collapsed into four categories: group instruction by regular teacher, individualized instruction by regular teacher, special teacher instruction, and teaching assistance by an aide or voluntary tutor. Constant terms and coefficients of determination are not reported, but they were similar to the values reported in Chapter 3. Of the regression coefficients that are at least twice their standard errors, those for group instruction are mostly positive; those for the other categories are mostly negative.

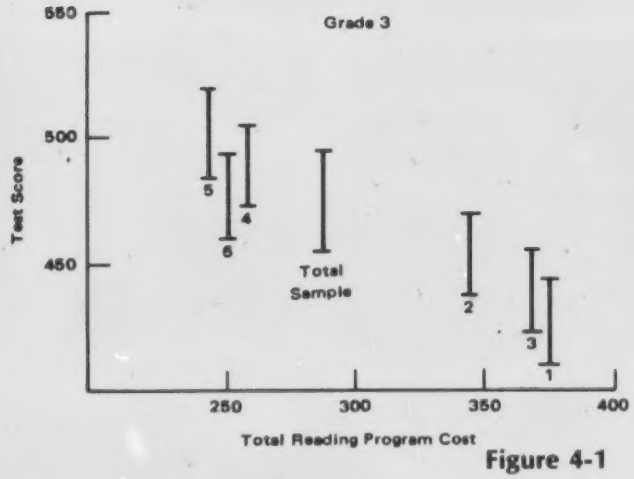
As noted in Chapter 3, the directions of the signs of the coefficients probably reflect the fact that lower achieving students tend to receive those types of services more often than do higher achieving students.

A different approach to program cost and achievement is summarized in Table 4-5 for Title I reading. A compensatory cost *increment* for Title I students was estimated as their total reading program cost minus the average reading program cost for non-CE students in the same school. The average cost increment for each grade level is presented. A residual gain score, also shown in the table, was calculated as the actual posttest score minus the expected posttest score, where the estimator for expected posttest score was derived as the regression of actual posttest on actual pretest.

In this case the sample used to determine the estimator was limited to a comparison group of non-CE students in non-CE schools who were identified by teachers as being in need of CE services (these students form Comparison Group A in Table 4-1); thus, the expected posttest score is roughly what one should expect in the absence of CE funding. Finally, the least-squares regression coefficients of residual gain on cost increment was calculated, with the results for each grade appearing in the table.



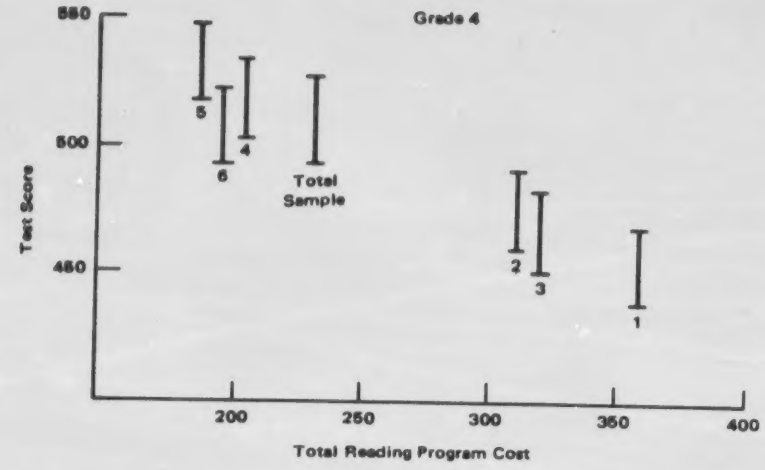


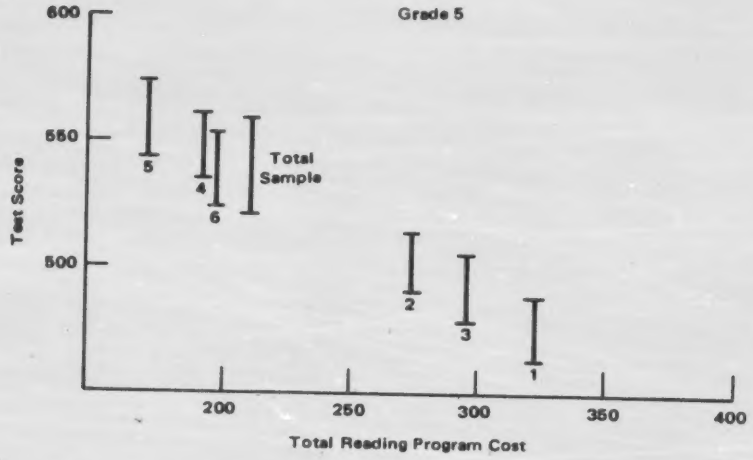


1 = Title I students in Title I schools
2 = Other-CE students in Title I schools
3 = Other-CE students in other-CE schools
4 = Non-CE students in Title I schools
5 = Non-CE students in other-CE schools
6 = Non-CE students in non-CE schools

Figure 4-1

Reading Achievement Performance *Versus* Program Cost by CE Selection Category Within Grade Level





1 = Title I students in Title I schools
2 = Other-CE students in Title I schools
3 = Other-CE students in other-CE schools
4 = Non-CE students in Title I schools
5 = Non-CE students in other-CE schools
6 = Non-CE students in non-CE schools

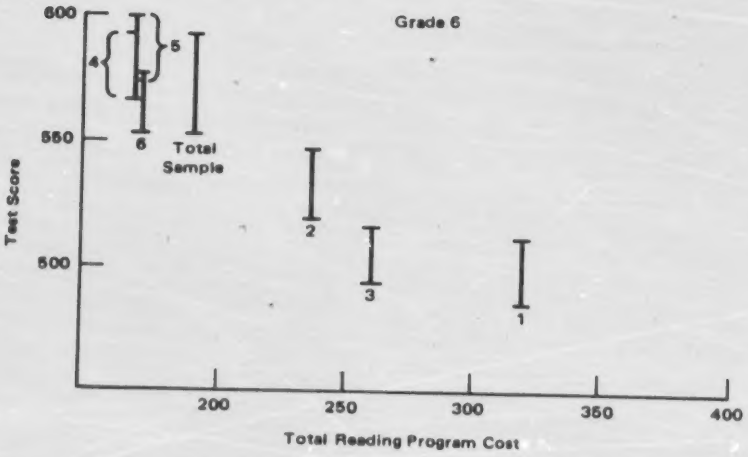


Figure 4-1 (Continued)

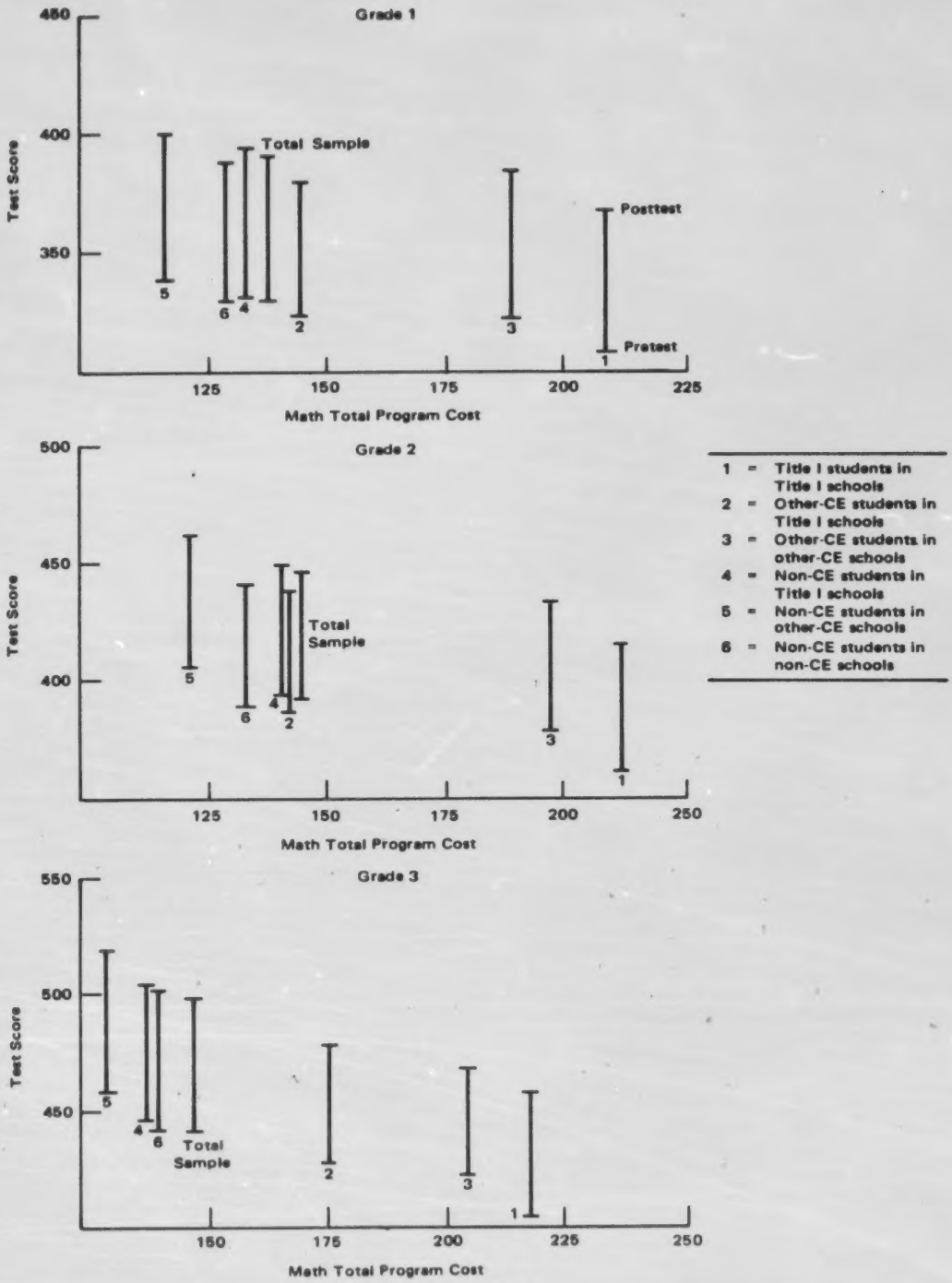


Figure 4-2

Math Achievement Performance *Versus* Program Cost by CE Selection Category Within Grade Level

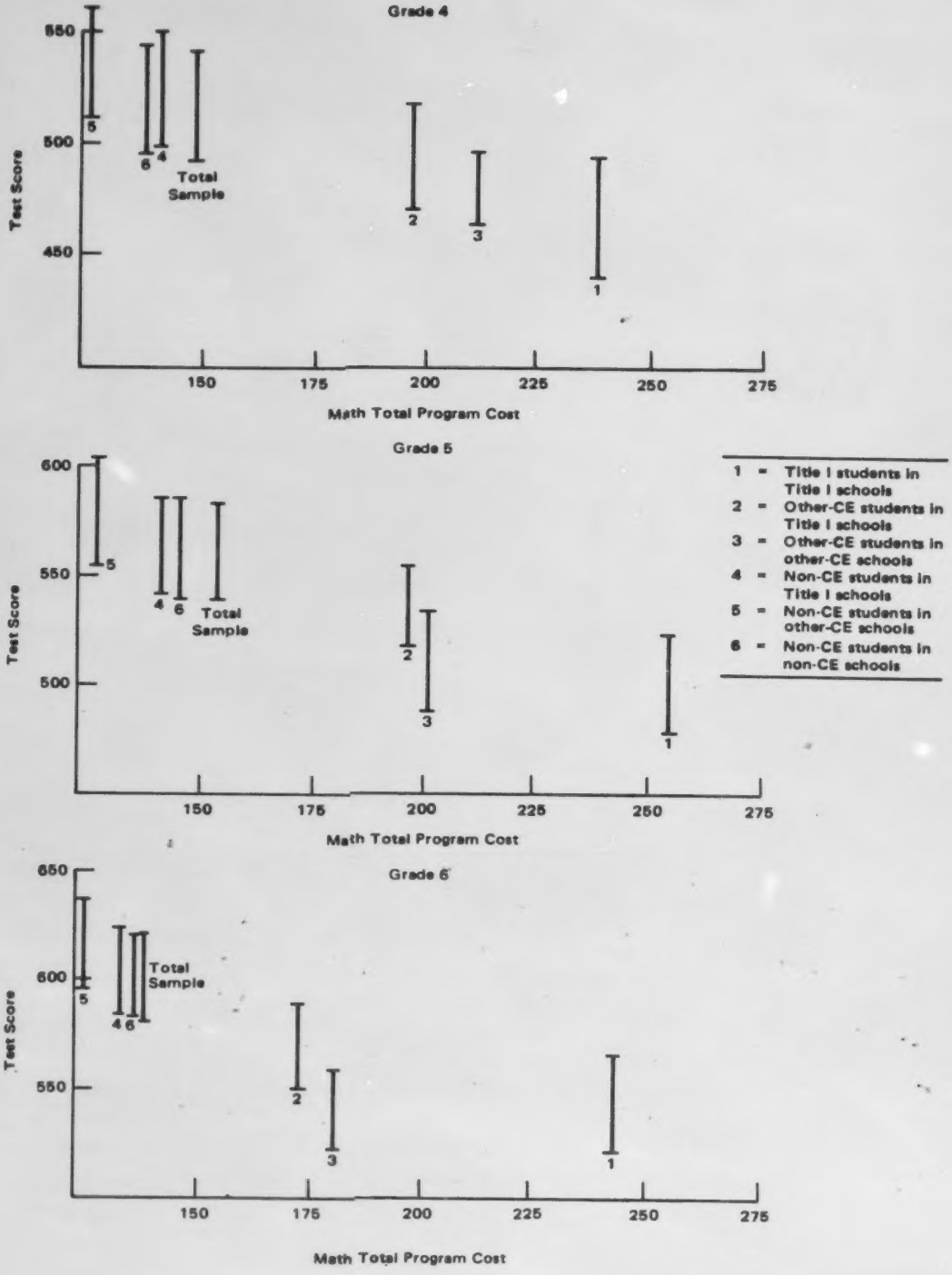


Figure 4-2 (Continued)

Table 4-3

Regression Coefficients for Reading Program Components (Collapsed) by CE Category Within Grade*

	Group Instruction	Individualized Instruction	Special Teacher Instruction	Aide or Tutor	Pretest
Grade 1					
Total Sample	.050	.005	−.039	−.048	.87
Title I	.059	(−.005)	(−.006)	−.050	.72
Other CE	.059	.002	−.032	.075	.85
Non-CE	.044	.007	−.058	−.006	.87
Grade 2					
Total Sample	.016	(−.003)	−.029	−.050	.82
Title I	(.013)	(−.007)	−.014	−.051	.68
Other CE	.049	(−.005)	−.021	(−.020)	.74
Non-CE	.016	(−.002)	−.036	(.019)	.84
Grade 3					
Total Sample	(.002)	−.007	−.023	−.069	.85
Title I	.016	(−.009)	(−.003)	(−.023)	.72
Other CE	.040	.005	−.007	(.039)	.79
Non-CE	(−.005)	−.007	−.039	−.093	.86
Grade 4					
Total Sample	(−.003)	−.011	−.029	(−.021)	.87
Title	.026	(.001)	(.000)	(.039)	.70
Other CE	(.016)	(−.014)	−.019	.100	.84
Non-CE	(−.008)	−.011	−.029	−.063	.88
Grade 5					
Total Sample	(.002)	(−.006)	−.024	−.092	.93
Title I	.026	(−.004)	(−.006)	(−.045)	.79
Other CE	(−.035)	−.012)	−.024	(.043)	.88
Non-CE	(.005)	(−.004)	−.025	−.110	.94
Grade 6					
Total Sample	.015	(.000)	−.015	(−.054)	.93
Title I	.046	.028	(.007)	(−.047)	.77
Other CE	.024	(.001)	−.026	(−.007)	.89
Non-CE	.016	(−.001)	(−.006)	(−.032)	.93

*Values in parentheses are less than twice their respective standard errors.

The results are not easy to interpret. The average cost increment hovers between $111 and $144. The average residual gains are small, but mostly positive, verifying that Title I students do slightly better, on average, than they would if Title I services were not received. The regression coefficients, which provide us with an index of the cost-effectiveness of incremental resources, are small relative to cost and relative to their own standard errors. Results of the parallel analysis for math, not reported here, were similar.

For the record, Table 4-6 summarizes affective scores for reading in parallel fashion to Tables 4-1 and 4-2. Affective change appears to be relatively independent of CE selection status, although Title I students obtain higher pretest and posttest affective scores on average.

Table 4-4

Regression Coefficients for Math Program Components (Collapsed) by CE Category Within Grade*

	Group Instruction	Individualized Instruction	Special Teacher Instruction	Aide or Tutor	Pretest
Grade 1					
Total Sample	.052	(–.005)	(–.017)	–.077	.82
Title I	.050	–.026	.025	.095	.73
Other CE	.110	.038	(.009)	.210	.74
Non-CE	.052	(.007)	–.015	–.140	.82
Grade 2					
Total Sample	.004	–.016	–.025	–.210	.80
Title I	.004	–.030	(–.007)	–.110	.67
Other CE	.120	(.013)	(–.016)	(.009)	.79
Non-CE	(–.004)	–.013	–.024	–.220	.80
Grade 3					
Total Sample	–.021	–.043	–.034	–.270	.82
Title I	(–.011)	–.041	(.015)	(.020)	.69
Other CE	–.056	–.098	–.100	–.300	.79
Non-CE	(–.017)	–.033	(–.008)	–.300	.81
Grade 4					
Total Sample	(–.013)	(–.002)	(–.013)	–.082	.85
Title I	.052	(.017)	.030	–.015	.75
Other CE	(–.016)	(–.039)	(–.029)	(–.015)	.80
Non-CE	–.022	(.000)	(–.007)	(.004)	.83
Grade 5					
Total Sample	(–.002)	–.017	–.026	–.110	.89
Title I	.037	–.019	(.009)	(–.011)	–.80
Other CE	(–.040)	(–.027)	.054	(–.001)	.85
Non-CE	(.003)	(–.007)	(–.018)	–.130	.89
Grade 6					
Total Sample	.033	(–.002)	(–.016)	–.140	.90
Title I	.058	(.011)	.030	(–.050)	.78
Other CE	(.043)	(.026)	(–.009)	(–.170)	.88
Non-CE	.029	(.005)	(–.042)	.036	.90

*Values in parentheses are less than twice their respective standard errors.

ACHIEVEMENT LEVEL AND LUNCH-PROGRAM PARTICIPATION

Blocking by achievement level is important because there is considerable sentiment that the behavior of costs relative to educational outcomes may differ markedly between low achievers and high achievers. Blocking on achievement is controversial: because of regression artifacts (not expected to be large because of the high test-retest correlations for the CTBS), achievement gains of students who score high on pretests tend to be dampened, whereas gains of students who score low tend to be inflated. We hope to mitigate this effect by basing our achievement-level blocking on the average of reading and math recommended-level pretest and posttest scores.

Table 4-5

Title I Incremental Cost and Residual Gain* for Reading, by Grade

	Grade					
	1	2	3	4	5	6
Reading						
Average Cost Increment	125	120	120	144	111	117
Average Residual Gain	.6	3.3	3.2	−.6	2.5	−1.6
Regression Coefficient	−.001	−.012	.004	−.001	−.012	.008
(standard error in parentheses)	(.005)	(.005)	(.004)	(.007)	(.007)	(.008)

*Residual gain is calculated here as actual minus expected posttest, where the estimator for expected posttest is derived from a comparision group of non-CE students in non-CE schools who were identified by teachers as being in need of CE services.

Table 4-6

Average Affective Scores and Reading Progam Cost by CE Category, by Grade*

	Affective Data			
	Pretest	Posttest	Gain	Mean Program Cost
Grade 2				
Total Sample	82	84	2	332
Title I	84	86	2	421
Other CE	80	83	3	386
Non-CE	81	83	2	299
Grade 3				
Total Sample	82	82	0	286
Title I	85	84	−1	381
Other CE	83	83	0	358
Non-CE	81	81	0	251
Grade 4				
Total Sample	79	79	0	231
Title I	80	81	1	360
Other CE	80	80	0	314
Non-CE	78	79	1	195
Grade 5				
Total Sample	78	77	−1	209
Title I	81	80	−1	324
Other CE	78	78	0	284
Non-CE	78	77	−1	183
Grade 6				
Total Sample	75	73	−2	185
Title I	80	80	0	320
Other CE	76	75	−1	246
Non-CE	75	72	−3	163

*Affective pretests were not administered to students in Grade 1, thus gains could not be calculated.

Participation in a reduced-fee, or free-lunch program provides a surrogate measure for identifying students who come from lower income families. Tables 4-7 and 4-8 present the reading and math program costs and achievement data for high and low achievers, and for participants and non-participants in lunch programs. Results for these blockings are compared with those for the total sample within grade. Mean reading program costs decrease from $341 in the first grade to $185 in the sixth grade. For math, means costs increase from $137 in the first grade to $152 in the fifth grade. In both reading and math, low achieving students receive more expensive programs and incur greater costs per unit of gain. Participants in lunch programs have lower pretest scores, receive more expensive programs, and have a greater cost per unit of gain.

We must point out, again, that the cost-per-unit of gain statistics are purely descriptive, and are not meant to indicate the relative (inverse) cost-effectiveness of reading programs provided to students in the various groupings. As should be apparent in the discussion throughout this chapter, educational resources, as measured by our cost metric, seem to have only a marginal independent affect upon achievement. The simple cost-per-unit-of-gain measure largely reflects that, on balance, educational resources are allocated more intensively to students with low pretest scores. Since gains are not proportionally greater for low achievers, the cost per unit of gain will tend to be higher for them.

Two other achievement-blocking arrangements were explored. In one case, the sample (within grade level) was divided into deciles based on the pretest. In the other, blocking divided the sample among quartiles based on residual gain score. The subsequent analyses were not very useful, and are not reported in this document.

ANALYSES OF STUDENTS WITH UNEXPECTED ACHIEVEMENT GAINS

Another type of analysis based upon achievement was devloped to compare students who achieved much better than expected with those who achieved much worse than expected, that is, the "outliers". The procedure was to estimate a residual gain score for each student as the difference between his or her actual and expected posttest scores, where the estimator for the expected posttest score was the least-squares regression of actual posttest on actual pretest across the total sample of students for each grade.

The high-gain group includes all students whose residual gain score exceeds +1 standard deviation of residual gains at the respective grade level. The low-gain group includes all students whose residual gain score was less than −1 standard deviation. Thus, each of the two groups contains roughly one-sixth of the student sample.

Average reading and math program costs for the high-gain group are contrasted with those of the low-gain group in Figures 4-3 and 4-4. Cost is on the vertical axis and grade level is indicated along the horizontal axis. Cost curves are presented for Title I students, for Other-CE students, and for non-CE students. The values in the inset tables indicate the differences in average reading program costs between the low-gain group and the high-gain group.

For reading, Other-CE and non-CE average costs for the low-gain group generally exceed those for the high-gain group, but the differences are within 10 percent. For Title I reading, costs for the high-gain students are higher in grades three through six. For Other-CE math, the excess cost of low-gain students over high-gain students reaches about 30 percent in the third grade.

Table 4-7

Reading Program Cost and Achievement Data by Grade, and by Achievement Group and Lunch Program Participation

Grouping	Achievement Data			Program Cost	
	Pretest	Posttest	Gain	Mean Cost	Cost/Gain
Grade 1					
Total	344	409	65	341	5
Low Achievement	316	370	54	362	7
High Achievement	363	435	72	327	5
Lunch Program	330	391	61	348	6
Non-Lunch	354	422	68	337	5
Grade 2					
Total	416	459	43	331	8
Low Achievement	373	413	40	366	9
High Achievement	445	490	45	308	7
Lunch Program	394	434	40	343	9
Non-Lunch	431	476	45	323	7
Grade 3					
Total	460	494	34	285	8
Low Achievement	412	444	32	335	10
High Achievement	494	528	34	251	7
Lunch Program	434	467	33	308	9
Non-Lunch	480	514	34	269	8
Grade 4					
Total	493	523	30	232	8
Low Achievement	441	469	28	281	10
High Achievement	533	564	31	194	6
Lunch Program	461	492	31	266	9
Non-Lunch	515	545	30	208	7
Grade 5					
Total	524	551	27	210	8
Low Achievement	468	492	24	250	10
High Achievement	566	596	30	179	6
Lunch Program	491	515	24	241	10
Non-Lunch	547	576	29	187	6
Grade 6					
Total	556	581	25	185	7
Low Achievement	499	521	22	222	10
High Achievement	600	628	28	157	6
Lunch Program	517	541	24	221	9
Non-Lunch	578	603	25	166	7

Table 4-8

Math Program Cost and Achievement Data by Grade, and by Achievement Group and Lunch Program Participation

Grouping	Achievement Data			Program Cost	
	Pretest	Posttest	Gain	Mean Cost	Cost/Gain
Grade 1					
Total	331	392	61	137	2
Low Achievement	303	355	52	152	3
High Achievement	349	417	68	127	2
Lunch Program	318	378	60	154	3
Non-Lunch	340	403	63	125	2
Grade 2					
Total	393	448	55	143	3
Low Achievement	357	406	49	160	3
High Achievement	417	477	70	132	2
Lunch Program	376	430	54	161	3
Non-Lunch	404	461	57	132	2
Grade 3					
Total	443	501	58	146	3
Low Achievement	404	454	50	165	3
High Achievement	470	533	63	132	2
Lunch Program	425	478	53	160	3
Non-Lunch	456	518	62	135	2
Grade 4					
Total	495	545	50	148	3
Low Achievement	448	494	46	168	4
High Achievement	531	585	54	133	2
Lunch Program	470	520	50	166	3
Non-Lunch	513	563	50	136	3
Grade 5					
Total	540	584	44	152	3
Low Achievement	488	526	38	175	5
High Achievement	579	628	49	134	3
Lunch Program	513	553	40	172	4
Non-Lunch	559	606	47	137	3
Grade 6					
Total	582	622	40	138	3
Low Achievement	528	562	34	156	5
High Achievement	625	670	45	125	3
Lunch Program	552	591	39	155	4
Non-Lunch	599	640	41	129	3

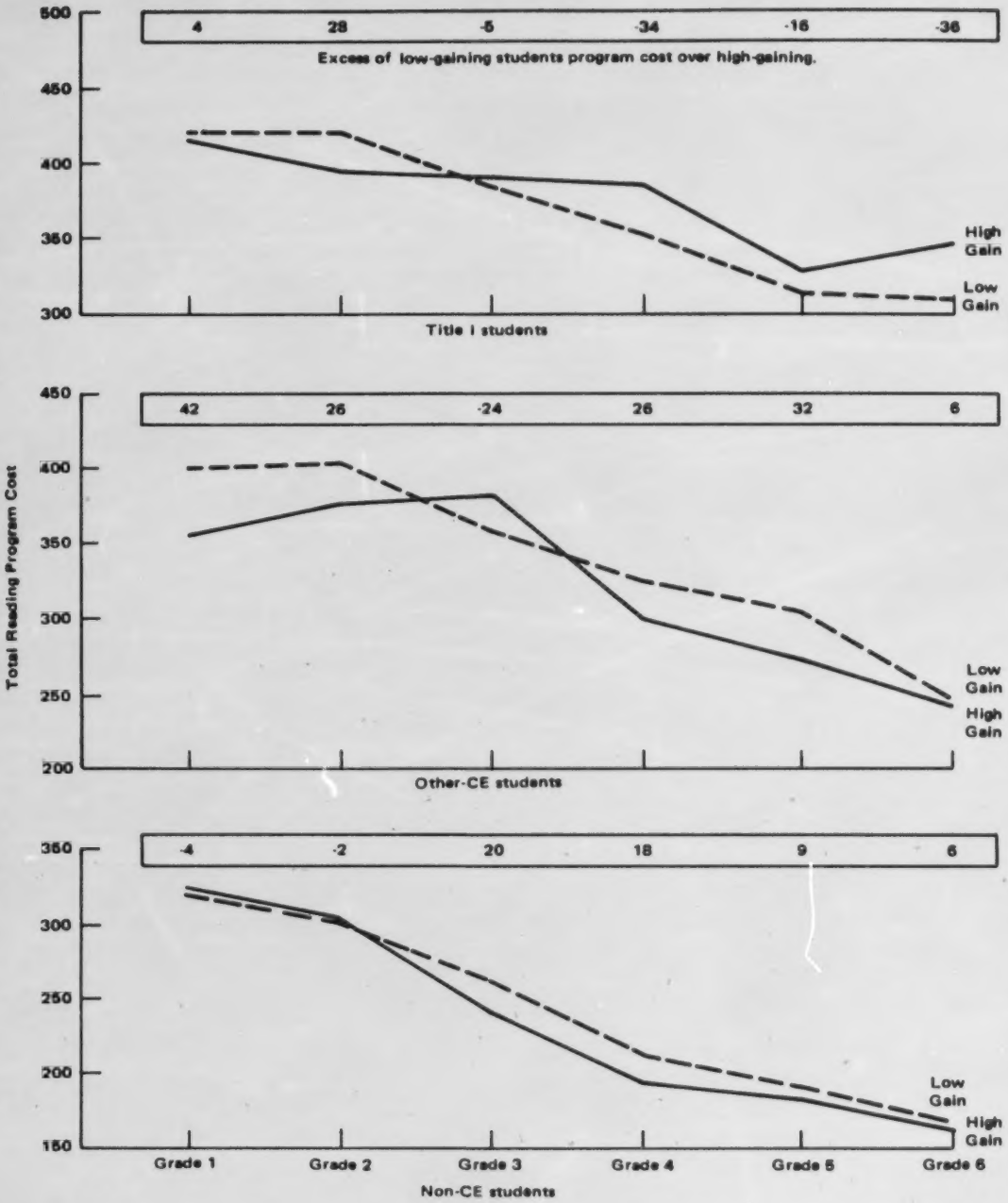


Figure 4-3

Comparison of Reading Program Costs for Low-Gaining Students and High-Gaining Students by Grade and CE Selection Status

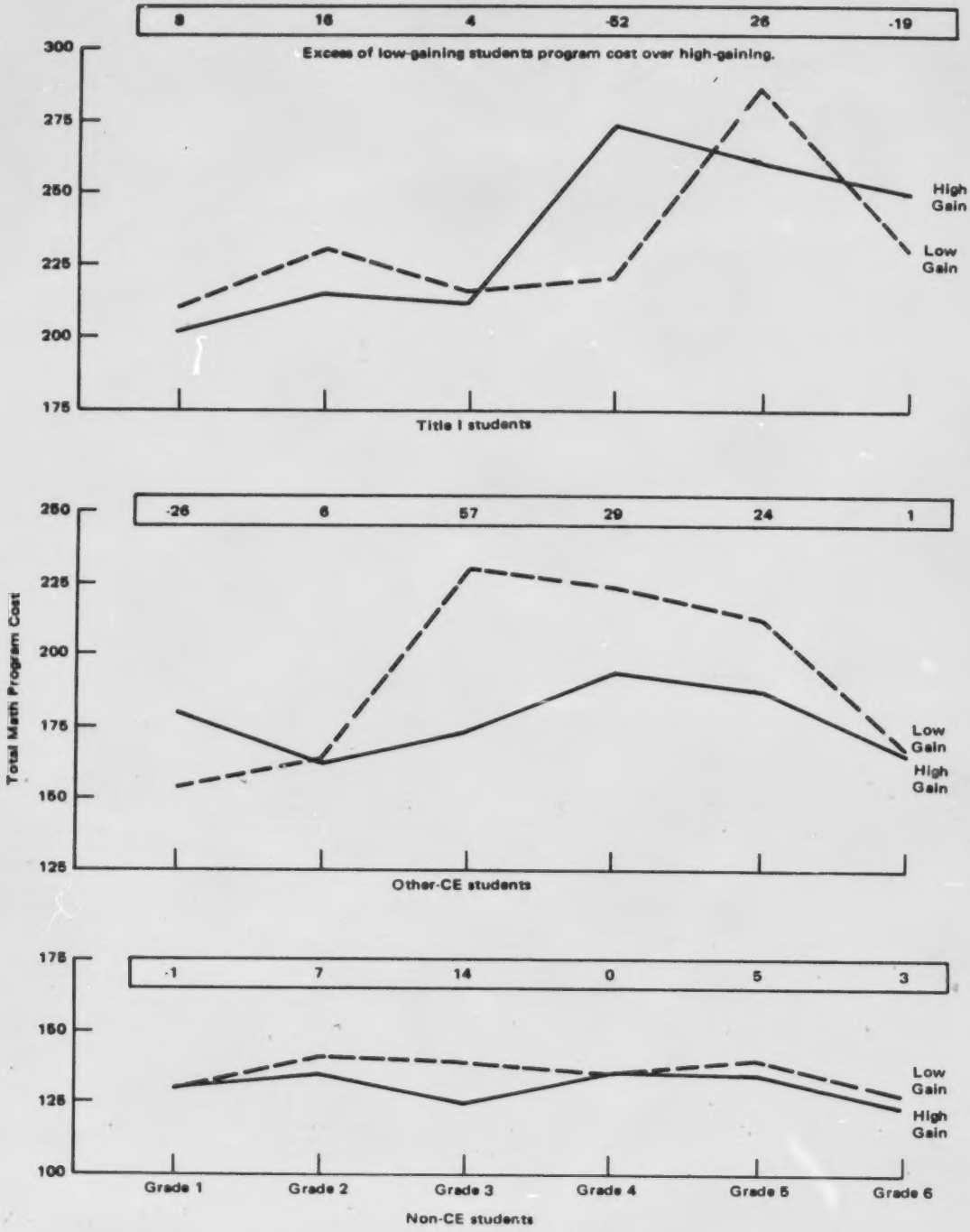


Figure 4-4

Comparison of Math Program Costs for Low-Gaining Students and High-Gaining Students by Grade and CE Selection Status

Six characteristics related to academic experience and socioeconomic status are contrasted for low-gain and high-gain groups in Table 4-9 and 4-10. The key to these is:

A. Percentage of students who received *health and nutrition* services during the previous school year.

B. Percentage of students who had some type of *preschool education* experience.

C. Percentage of students who participated in free or reduced-fee *lunch* programs.

D. Percentage of students whose *reading teacher* had over fifteen years of experience.

E. Percentage of students whose *parent involvement* rating exceeds three on a scale of one to twelve.

F. Percentage of students whose *parent education* is high (i.e., mother has been educated beyond high school).

From Tables 4-9 and 4-10, it appears that there is a very slightly lower incidence of preschool education experience among the low-gain students. Low-gain students tend to come from lower income families, judging from lunch program participation. Teachers are somewhat less experienced in the high-gain Title I reading group and for the first three grades of the high-gain Other-CE reading group. Parent involvement is almost always higher in the high-gain groups; parents of the high-gain students are also more educated.

Several school and district management characteristics were also examined, but we found very little differentiation between high-gain and low-gain groups. These characteristics included composite variables meant to reflect: (1) district control of instruction, (2) principal's instructional leadership, (3) teacher involvement in instructional decisionmaking, and (4) staff belief that schooling makes a difference.

ANALYSES OF STUDENTS STRATIFIED BY PROGRAM COST

Another way of investigating the impact of cost on achievement is to look at the differences in outcomes that result from the use of relatively equal amounts of resources. We have elected to analyze only reading data and, within reading, only data from the Title I students in Title I schools (plus the comparison group of non-CE students in non-CE schools who were judged by teachers to be in need of CE services). The achievement data for the cost strata are shown in Table 4-11. The conclusions that can be drawn are limited due to the large standard errors for some of the strata with small numbers of students. The stratum-size problem is critical for the comparison group strata where mean reading program cost is more than $400.

An examination of achievement data, shown in Table 4-11, reveals consistent, small differences across strata. Students in the higher cost programs consistently score lower on pretest and posttest than do those in the lower cost programs; the raw gains across cost strata are about equal, except for strata with small sample sizes. Title I students in all but the highest cost stratum gain at a slightly higher rate than comparison students in the lower grades; this pattern is weaker in the upper grades. More money seems to have no significant impact on performance relative to the overall mean gain for the students in a particular grade.

Table 4-9

Other Characteristics of Reading Outliers by CE Selection Status and Grade, in Percentages

Grade and Characteristic	Title I		Other CE		Non-CE		Total Sample	
	Low	High	Low	High	Low	High	Low	High
Grade 1								
Health and Nutrition Services	14	26	20	18	2	2	7	6
Some Preschool Experience	86	94	91	92	92	95	90	95
Free- or Reduced-Price Lunch	73	73	57	42	45	25	53	31
Experienced Reading Teachers	74	69	70	51	69	73	70	71
Involved Parents	10	17	19	23	14	25	14	24
Educated Mothers*	7	13	13	37	16	38	14	36
Grade 2								
Health and Nutrition Services	20	13	21	11	4	2	9	5
Some Preschool Experience	88	90	91	92	92	94	91	93
Free- or Reduced-Price Lunch	75	64	58	39	48	25	55	33
Experienced Reading Teachers	77	66	76	78	71	74	73	73
Involved Parents	12	17	16	34	17	26	16	25
Educated Mothers	8	12	13	26	22	34	18	29
Grade 3								
Health and Nutrition Services	14	18	11	11	3	2	7	5
Some Preschool Experience	85	88	92	94	90	93	89	92
Free- or Reduced-Price Lunch	70	62	60	49	45	23	52	31
Experienced Reading Teachers	63	60	73	71	73	72	71	71
Involved Parents	12	16	18	26	12	22	13	21
Educated Mothers	8	12	14	28	20	38	17	35

Table 4-9 (Continued)

Grade 4								
Health and Nutrition Services	20	20	12	12	3	3	7	6
Some Preschool Experience	81	84	85	95	87	92	86	91
Free- or Reduced-Price Lunch	74	72	65	53	45	29	53	38
Experience Reading Teachers	76	70	78	81	73	71	74	72
Involved Parents	15	14	11	19	13	21	13	20
Educated Mothers	5	9	12	18	21	34	17	30
Grade 5								
Health and Nutrition Services	14	12	8	7	4	3	6	4
Some Preschool Experience	80	82	84	87	85	90	84	88
Free- or Reduced-Price Lunch	76	68	66	43	48	28	54	34
Experienced Reading Teachers	71	70	73	75	74	70	73	70
Involved Parents	12	16	8	20	11	19	11	19
Educated Mothers	7	9	9	21	20	33	17	29
Grade 6								
Health and Nutrition	28	24	18	22	2	2	8	5
Some Preschool Experience	82	78	78	82	83	87	83	86
Free- or Reduced-Price Lunch	81	72	59	52	38	23	46	29
Experienced Reading Teachers	68	63	68	77	66	72	67	71
Involved Parents	9	9	9	9	8	12	9	12
Educated Mothers	4	7	6	22	20	30	17	27

*See text for explanation of characteristics.

Table 4-10

Other Characteristics of Math Outliers by CE Selection Status and Grade, in Percentages

Grade and Characteristic	Title I		Other-CE		Non-CE		Total Sample	
	Low	High	Low	High	Low	High	Low	High
Grade 1								
Health and Nutrition Services	20	29	28	15	4	1	8	5
Some Preschool Experience	92	94	96	95	94	95	94	95
Free- or Reduced-Price Lunch	86	82	61	42	46	31	52	36
Experienced Reading Teachers	63	72	71	49	71	73	70	71
Involved Parents	12	20	18	24	17	23	17	23
Educated Mothers*	7	13	13	34	17	30	16	29
Grade 2								
Health and Nutrition Services	23	17	23	20	4	2	9	5
Some Preschool Experience	92	91	97	98	93	94	93	94
Free- or Reduced-Price Lunch	82	78	65	49	45	31	52	37
Experienced Reading Teachers	76	70	81	82	74	77	75	77
Involved Parents	18	14	21	34	20	26	19	26
Educated Mothers	8	12	18	26	19	33	18	31
Grade 3								
Health and Nutrition Services	27	16	25	6	3	2	9	3
Some Preschool Experience	86	85	96	99	89	93	89	93
Free- or Reduced-Price Lunch	80	76	61	32	48	22	54	26
Experienced Reading Teachers	67	67	79	59	68	73	69	72
Involved Parents	14	10	24	17	17	22	17	21
Educated Mothers	8	12	16	47	17	39	16	37

Table 4-10 (Continued)

Grade 4								
Health and Nutrition Services	29	18	14	15	4	4	7	5
Some Preschool Experience	85	87	90	94	91	92	90	92
Free- or Reduced-Price Lunch	73	71	60	45	40	30	46	34
Experienced Reading Teachers	74	72	73	87	74	71	74	72
Involved Parents	19	18	17	28	16	20	16	21
Educated Mothers	8	11	14	16	20	32	19	30
Grade 5								
Health and Nutrition Services	27	7	1	5	3	3	5	4
Some Preschool Experience	87	81	90	92	87	91	87	90
Free- or Reduced-Price Lunch	81	68	64	46	46	25	51	29
Experienced Reading Teachers	72	77	64	71	72	29	71	70
Involved Parents	12	11	10	21	14	19	14	19
Educated Mothers	6	9	18	18	18	30	17	28
Grade 6								
Health and Nutrition Services	38	42	17	14	3	2	6	4
Some Preschool Experience	88	84	87	87	84	86	84	86
Free- or Reduced-Price Lunch	71	80	61	52	36	24	41	29
Experienced Reading Teachers	69	63	70	74	70	72	70	71
Involved Parents	15	9	13	11	10	13	11	12
Educated Mothers	6	8	10	9	18	32	17	30

*See text for explanation of characteristics.

Table 4-11

Reading Achievement Data for Students Stratified by Cost: Title I Students *versus* Comparision Group Students

Grade and Student Group	Program Cost: Less Than 200	200-<300	300-<400	400-<500	More Than 500
Grade 1					
Title I					
Posttest	389	380	384	388	380
Pretest	328	322	324	324	323
Raw Gain	61	58	60	64	57
% Gain	19	18	19	20	18
N	267	617	546	546	767
Comparison Group*					
Posttest	368	374	371	382	379
Pretest	318	324	320	320	316
Raw Gain	50	50	51	62	63
% Gain	16	15	16	19	20
N	68	218	88	86	60
Posttest Difference	21	6	13	6	1
Pretest Difference	10	−2	4	4	7
Grade 2					
Title I					
Posttest	427	422	432	421	420
Pretest	382	381	383	382	379
Raw Gain	45	40	49	39	41
% Gain	12	10	13	10	11
N	337	488	691	582	825
Comparison Group*					
Posttest	428	410	421	419	396
Pretest	384	376	380	387	350
Raw Gain	44	34	41	32	46
% Gain	11	9	11	8	13
N	146	268	152	46	53
Posttest Difference	−1	12	11	2	24
Pretest Difference	−2	5	3	−5	29

Grade and Student Group	Program Cost: Less Than 200	200-<300	300-<400	400-<500	More Than 500
Grade 3					
Title I					
Posttest	462	454	447	448	447
Pretest	427	418	414	411	410
Raw Gain	35	37	33	36	37
% Gain	8	9	8	9	9
N	302	762	684	504	609
Comparison Group*					
Posttest	460	447	443	435	424
Pretest	419	418	414	407	410
Raw Gain	41	29	30	28	14
% Gain	10	7	7	7	3
N	137	166	165	62	31
Posttest Difference	2	7	4	13	23
Pretest Difference	8	0	0	4	0
Grade 4					
Title I					
Posttest	479	474	470	466	476
Pretest	451	445	438	432	432
Raw Gain	29	29	32	34	35
% Gain	6	7	7	8	8
N	374	497	615	424	396
Comparison Group*					
Posttest	483	476	468	442	429
Pretest	451	444	436	418	419
Raw Gain	32	33	32	24	10
% Gain	7	7	7	6	2
N	279	126	100	53	26
Posttest Difference	−4	−2	2	24	47
Pretest Difference	0	1	2	14	13

Table 4-11 (Continued)

Grade 5					
Title I					
Posttest	499	491	492	486	481
Pretest	475	466	464	461	455
Raw Gain	25	25	27	25	26
% Gain	5	5	6	5	6
N	465	597	499	268	240
Comparison Group*					
Posttest	487	492	472	463	496
Pretest	462	472	452	444	469
Raw Gain	25	20	20	19	27
% Gain	5	4	4	4	6
N	296	118	58	16	30
Posttest Difference	12	−1	20	23	−15
Pretest Difference	13	−6	12	17	−14
Grade 6					
Title I					
Posttest	522	513	511	515	516
Pretest	496	491	483	487	484
Raw Gain	26	22	28	28	32
% Gain	5	4	6	6	7
N	369	575	471	279	200
Comparison Group*					
Posttest	525	512	502	488	503
Pretest	503	484	471	464	471
Raw Gain	22	28	31	24	32
% Gain	5	6	7	5	7
N	410	156	37	21	36
Posttest Difference	−3	1	9	27	13
Pretest Difference	−7	7	12	23	13

*Same as Comparison Group A in Table 4-1.

Where we looked at the cost to achieve several levels of equal-gain, the results (not shown) were the same across the equal-gain groups. That is, the mean costs, the standard deviation, and the range of the costs for the equal-gain groups were exactly the same.

ANALYSES WITH INSTRUCTIONAL CONFIGURATIONS

A typology of instructional delivery configurations was developed, among which all students can be allocated depending upon the particular characteristics of their reading and math programs. The intent of the typology was to provide a means for blocking the sample into groups of students who have relatively homogeneous reading and math programs. The goal was to specify configurations that are not too gross to discriminate meaningfully among reading (or math) programs, yet are few enough in number to provide a relatively concise description of the predominant patterns of instructional delivery.

The typology was constructed empirically using an intensity score (in hours) for each of the ten program components in each student's reading (or math) program. At the first cut, the total number of configurations numbered in the hundreds. This was reduced to twenty-eight and then to sixteen by collapsing similar program components, by collapsing intensity scores into broad categories, and by making judicious combinations of the remaining configurations. Tables 4-12 and 4-13 define the 16 configurations used in the analysis in terms of the numbers of hours a student spends in each of five instructional modes:

Group instruction by regular teacher
Independent seatwork
Small group or individual instruction by regular teacher
Instruction by special teacher
Instruction by aide

The distribution of students among these configurations is, of course, uneven. A '+' in the right-hand columns indicates that a configuration (for reading or math) is common, that is, there are more than 400 students in fifty schools. A 'o' indicates that the configuration is not common, but has more than 200 students in 30 schools. Configurations with a '—' represent fewer students and/or fewer schools. Most of our analyses were confined to the common configurations.

Average reading program costs and numbers of students for each configuration in each grade are presented in Tables 4-14 and 4-15. As would be expected, costs are higher for the more labor intensive configurations, peaking in configurations that utilize both individual instruction by regular teachers and instruction by special teachers. For reading, the upper grades rely more on the minimal programs and programs employing simple group instruction; group instruction is also prevalent in the lower grades, but there is also greater utilization of special teachers and somewhat greater utilization of individualized instruction (by regular teachers). For math, this pattern is reversed somewhat, although individualized instruction is common in all grades.

Table 4-12

Configurations of Reading Instruction: The Instructional Components and Their Incidence in the SES Sample

Program Component	Hours per Week of Instruction in Each Instructional Mode					Incidence of Configuration by Grade*					
	Group Instruction by Regular Teacher	Independent Seatwork	Small Group or Individual Instruction by Regular Teacher	Instruction by Special Teacher	Instruction by an Aide	Grade 1	2	3	4	5	6
A. Minimal program with no seatwork	<2.5	<2.5	<0.5	<0.5	<1.5	–	0	+	+	+	+
B. Minimal program with seatwork	<2.5	>2.5	<0.5	<0.5	<1.5	0	+	+	+	+	+
C. Minimal program with aide	<2.5	–	<0.5	<0.5	>1.5	–	–	–	–	–	–
D. Group instruction with no seatwork	>2.5	<2.5	<0.5	<0.5	<1.5	+	+	+	+	+	+
E. Group instruction with seatwork	>2.5	>2.5	<0.5	<0.5	<1.5	+	–	+	+	+	+
F. Group instruction plus aide	>2.5	–	<0.5	<0.5	>1.5	+	0	0	–	–	–
G. Individual instruction with no seatwork	<2.5	<2.5	>0.5	<0.5	<1.5	+	+	+	+	+	+
H. Individual instruction with seatwork	<2.5	>2.5	>0.5	<0.5	<1.5	+	+	+	+	+	+
I. Individual instruction plus aide	<2.5	–	>0.5	<0.5	>1.5	+	+	0	–	–	–
J. Individual instruction plus group instruction	>2.5	–	>0.5	<0.5	<1.5	+	+	+	+	+	+
K. Individual instruction plus group instruction and aide	>2.5	–	>0.5	<0.5	>1.5	0	0	–	–	–	–
L. Special teacher	<2.5	–	<0.5	>0.5	<1.5	–	0	+	+	+	+
M. Special teacher plus group instruction	>2.5	–	<0.5	>0.5	<1.5	+	+	+	+	+	+
N. Special teacher plus group instruction and aide	–	–	<0.5	>0.5	>1.5	–	0	–	–	–	–
O. Individual instruction and special teacher	<2.5	–	>0.5	>0.5	–	+	+	+	+	+	+
P. Individual instruction and special teacher plus group instruction	>2.5	–	>0.5	>0.5	–	+	+	+	+	+	–

*'+' indicates that students in the respective configuration number at least 400 in at least 50 schools; '0' indicates that at least 200 students in at least 30 schools are represented;

'–' indicates that less than 200 students or less than 30 schools are represented.

Table 4-13

Configurations of Math Instruction: The Instructional Components and Their Incidence in the SES Sample

Program Component	Hours per Week of Instruction in Each Instructional Mode					Incidence of Configuration by Grade*					
	Group Instruction by Regular Teacher	Independent Seatwork	Small Group or Individual Instruction by Regular Teacher	Instruction by Special Teacher	Instruction by an Aide	Grade 1	2	3	4	5	6
A. Minimal program with no seatwork	<2.5	<1.5	<0.5	<0.5	<1.5	+	+	+	–	–	–
B. Minimal program with seatwork	<2.5	>1.5	<0.5	<0.5	<1.5	+	+	+	+	+	+
C. Minimal program with aide	<2.5	–	<0.5	<0.5	>1.5	–	–	–	–	–	–
D. Group instruction with no seatwork	>2.5	<1.5	<0.5	<0.5	<1.5	+	+	+	+	+	+
E. Group instruction with seatwork	>2.5	>1.5	<0.5	<0.5	<1.5	+	+	+	+	+	+
F. Group instruction plus aide	>2.5	–	<0.5	<0.5	>1.5	–	–	–	–	–	–
G. Individual instruction with no seatwork	<2.5	<1.5	>0.5	<0.5	<1.5	+	+	+	+	+	+
H. Individual instruction with seatwork	<2.5	>1.5	>0.5	<0.5	<1.5	+	+	+	+	+	+
I. Individual instruction plus aide	<2.5	–	>0.5	<0.5	>1.5	0	–	–	–	–	–
J. Individual instruction plus group instruction	>2.5	–	>0.5	<0.5	<1.5	+	+	+	+	+	+
K. Individual instruction plus group instruction and aide	>2.5	–	>0.5	<0.5	>1.5	–	–	–	–	–	–
L. Special teacher	<2.5	–	<0.5	>0.5	<1.5	+	+	+	+	+	+
M. Special teacher plus group instruction	>2.5	–	<0.5	>0.5	<1.5	0	+	+	+	+	+
N. Special teacher plus group instruction and aide	–	–	<0.5	>0.5	>1.5	–	–	–	–	–	–
O. Individual instruction and special teacher	<2.5	–	>0.5	>0.5	–	–	0	+	+	+	+
P. Individual instruction and special teacher plus group instruction	>2.5	–	>0.5	>0.5	–	–	–	–	–	–	–

*'+' indicates that students in the respective configuration number at least 400 in at least 50 schools; '0' indicates that at least 200 students in at least 30 schools are represented;

'–' indicates that less than 200 students or less than 30 schools are represented.

Table 4-14

Reading Program Costs and Numbers of Participants (in parentheses) by Instructional Configuration and by Grade*

		Grade					
		1	2	3	4	5	6
Minimal Program							
With no seatwork	A.	–	–	134 (557)	122 (828)	107 (1314)	90 (2463)
With seatwork	B.	–	159 (481)	152 (671)	131 (1291)	133 (1365)	121 (1283)
Group Instruction							
With no seatwork	D.	229 (2613)	224 (2578)	193 (3202)	161 (4931)	149 (5664)	137 (6537)
With seatwork	E.	275 (3927)	259 (3225)	221 (2668)	192 (1680)	188 (1412)	190 (1310)
Plus aide	F.	305 (809)	–	–	–	–	–
Individual Instruction							
With no seatwork	G.	381 (1173)	382 (1119)	324 (1208)	314 (1097)	313 (1244)	298 (1399)
With seatwork	H.	402 (1567)	382 (1579)	344 (1674)	285 (1202)	274 (1056)	249 (935)
Plus aide	I.	398 (664)	381 (400)	–	–	–	–
Plus group instruction	J.	389 (2677)	387 (1493)	338 (1235)	305 (986)	279 (897)	265 (974)
Special Teacher	L.	–	–	350 (328)	300 (534)	291 (497)	215 (1374)
Plus group instruction	M.	413 (591)	377 (905)	340 (934)	334 (845)	310 (784)	298 (770)
Individual Instruction and Special Teacher	O.	556 (895)	556 (1086)	512 (1020)	476 (798)	455 (645)	420 (589)
Plus group instruction	P.	531 (509)	527 (518)	485 (389)	468 (281)	440 (201)	–

*Data are presented only for the 13 configurations represented by at least 400 students in at least 50 schools, (or by at least 200 students from at least 75 schools).

Table 4-51

Math Program Costs and Numbers of Participants (in parentheses) by Instructional Configuration and by Grade*

		Grade 1	2	3	4	5	6
Minimal Program With no seatwork	A.	87 (1980)	96 (1438)	91 (879)			
With seatwork	B.	99 (3371)	103 (3636)	105 (3329)	103 (2970)	104 (2455)	96 (2894)
Group Instruction With no seatwork	D.	111 (3788)	117 (2976)	115 (3280)	113 (4771)	111 (5576)	112 (7473)
With seatwork	E.	129 (2906)	139 (3047)	128 (2990)	126 (2320)	132 (2533)	127 (2242)
Individual Instruction With no seatwork	G.	221 (888)	236 (706)	280 (486)	282 (528)	346 (676)	277 (850)
With seatwork	H.	197 (1403)	220 (1373)	207 (1694)	218 (1568)	225 (1538)	204 (1452)
Plus group instruction	J.	242 (892)	242 (573)	233 (763)	236 (791)	245 (843)	250 (850)
Special Teacher	L.	188 (320)	228 (279)	239 (380)	247 (467)	249 (378)	196 (555)
Plus group instruction	M.			241 (547)	234 (580)	257 (525)	232 (524)
Individual Instruction and Special Teacher	O.			358 (243)	389 (343)	334 (355)	363 (267)

*Data are presented only for the 10 configurations represented by at least 400 students in at least 50 schools, (or by at least 200 students from at least 50 schools).

Table 4-16 indicates the more frequently employed instructional configurations for outlier groups (low-gain and high-gain) for each grade level, that is, the configurations that account for 20 percent or more of the students in the respective outlier groups are identified. The data do not show great differences between configurations for low-gain and high-gain students. Group Instruction plus 'seatwork' is frequently associated with non-CE high-gainers in the primary grades, in both reading and math. Individual instruction plus special teacher is frequent with CE reading low-gainers in the primary grades, and individual instruction plus seatwork is frequent with Other-CE math high-gainers in the upper elementary grades.

Table 4-16

Most Frequent Instructional Configurations for Achievement Outliers by Grade*

	Configurations**									
	Reading					Math				
	A,B	D	E	M	O	A,B	D	E	H	M
Grade 1										
Total Sample			H			LH	LH	H		
Title I						H				H
Other-CE						LH				
Non-CE			LH			LH	LH	H		
Grade 2										
Total Sample			H			LH	H			
Title I						LH				
Other-CE					L	LH				
Non-CE		LH	LH			LH	H	LH		
Grade 3										
Total Sample		LH	H			LH	H	H		
Title I					LH					H
Other-CE					L			H		
Non-CE		LH	H			LH	LH	H		
Grade 4										
Total Sample		LH				LH	LH			
Title I				L	H					L
Other-CE					L			H		
Non-CE		LH				LH	LH			
Grade 5										
Total Sample		LH					LH			
Title I										H
Other-CE									H	
Non-CE	H	LH				L	LH			
Grade 6										
Total Sample	H	LH					LH			
Title I										
Other-CE							L		L	
Non-CE	LH	LH				H	H		H	

*Letter (L for low outliers and H for high outliers) indicates that at least 20 percent of students in grouping have indicated configuration.

**Key for configuration code:
A,B—Minimal Program
D—Group Instruction
E—Group Instruction plus Seatwork
H—Individual Instruction plus seatwork
M—Group plus Special Teacher
O—Individual Instruction plus Special Teacher

Average pretest and posttest scores for the various configurations are charted against average program cost in Figures 4-5 and 4-6 in the same manner as in Figure 4-1. For both reading and math, the more expensive configurations are employed for students with lower pretest scores. This tendency becomes more pronounced in the upper grades. Students in configurations that employ individualized instruction by the regular teacher tend to have higher pretest scores than do students in configurations that employ special teachers, although the average costs for the two kinds of configurations are about the same. It is striking that the amount of gain for all groups within a given grade level is so uniform, despite different costs and different initial achievement levels.

In an attempt to get a cost-effectiveness index for each configuration, regression computations were performed with the posttest score as the dependent variable and the pretest score and reading total program cost as the independent variables. The regression coefficients for cost are displayed in Tables 4-17 and 4-18.

The failure to obtain consistent results (Tables 4-17 and 4-18) may derive from the use of the single-cost-variable model to make comparisons among groupings that differ substantially in the way instructional resources are deployed. The alternative is to employ regression models where the cost is specified as the ten separate program component cost variables. While this specification precludes obtaining a single index of the returns in achievement gain attributable to cost (as in Tables 4-17 and 4-18), it allows the regression calculations to weight optimally the several program components. The coefficients of determination (R^2) for posttest and total program cost (within configurations) are much smaller than the multiple R^2 values for posttest with the ten program component costs (within configuration). Even so, the program component regression coefficients were generally trivial in magnitude, and it would not be productive to report them for each instructional configuration. Instead, Table 4-19 presents the proportions of posttest variance collectively accounted for by program component costs in each of six families of instructional configurations (see Table 4-12 for the key to the configuration identifiers):

1. Minimal Programs (configurations A and B)
2. Group Instruction (configurations D and E)
3. Individual Instruction (configurations G, H, I, and J)
4. Special Teachers (configurations L, M, and N)
5. Aides (configurations C and F)
6. Individual Instruction Plus Special Teacher (configurations O and P)

It is clear from the tables that program component costs account for only a small proportion of posttest variance, once the proportion attributable to pretest has been removed. Although the proportions are relatively large for the families of configurations that stress the use of aides in math, this family represents relatively few students from few schools.

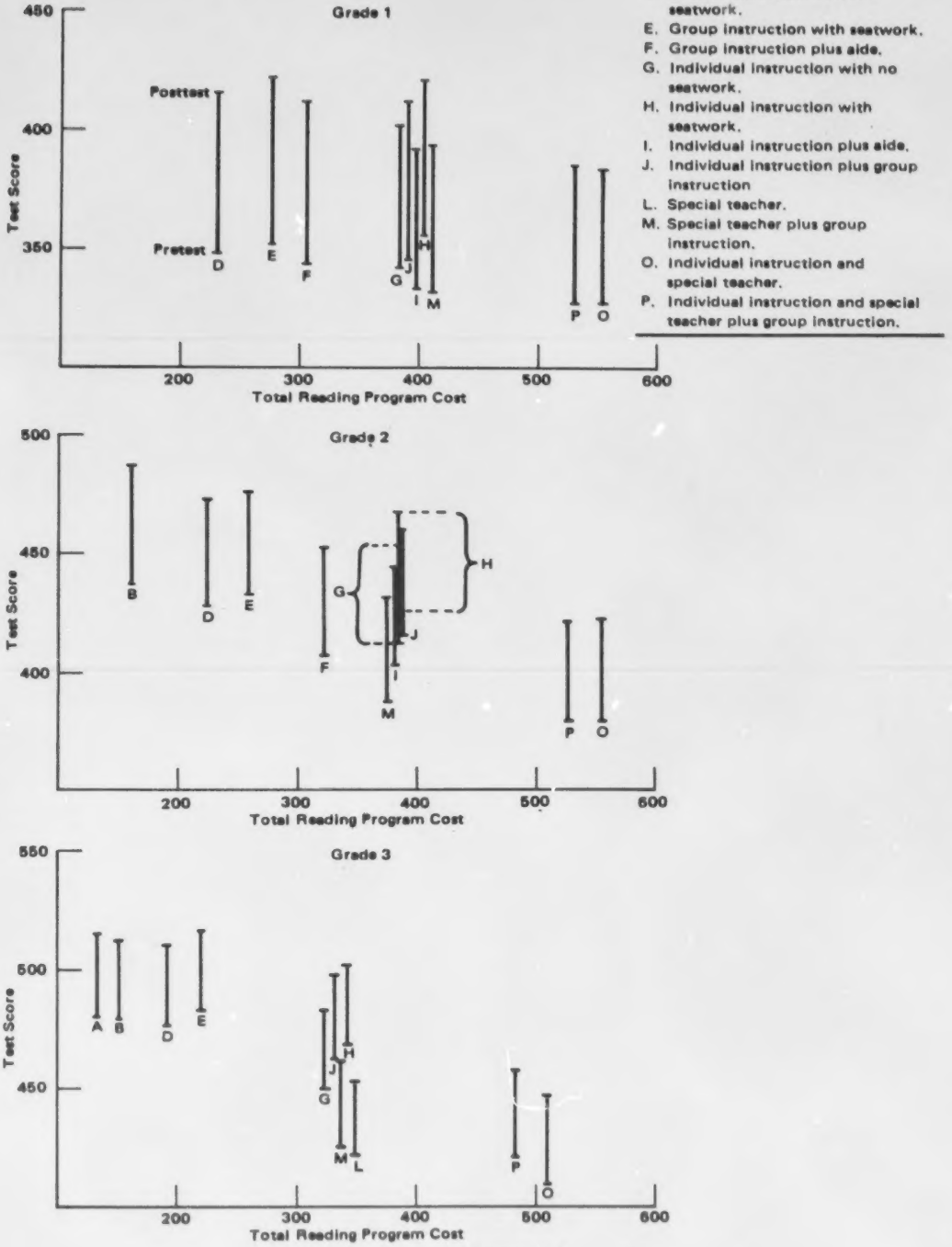
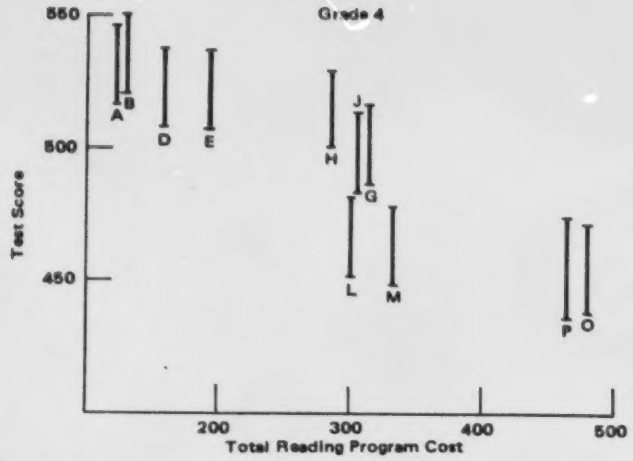
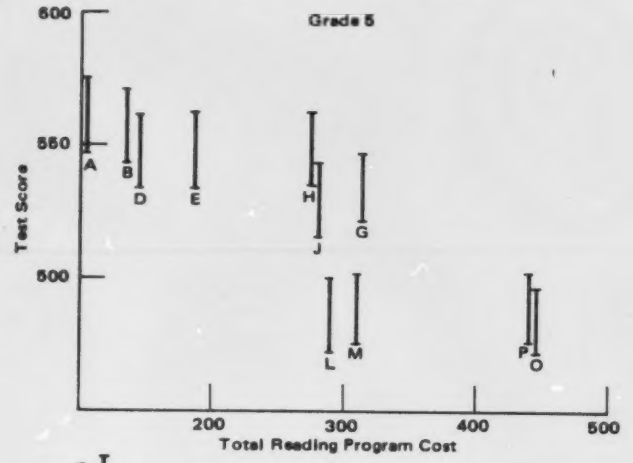
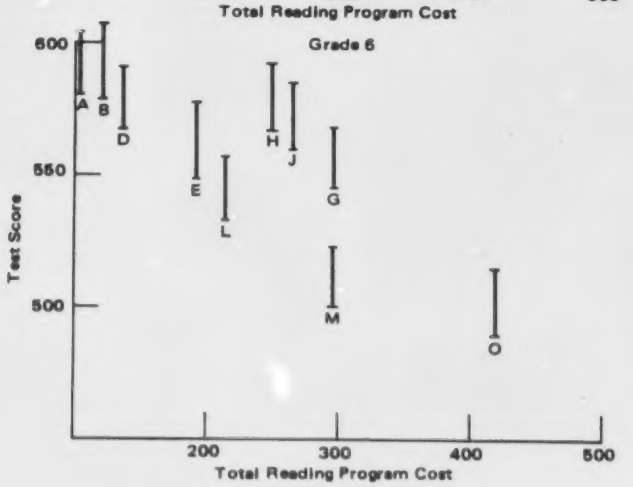


Figure 4-5

Reading Achievement Performance *Versus* Program Cost
by Instructional Configuration Within Grade Level
(See Table 4-12 for Configuration Code)

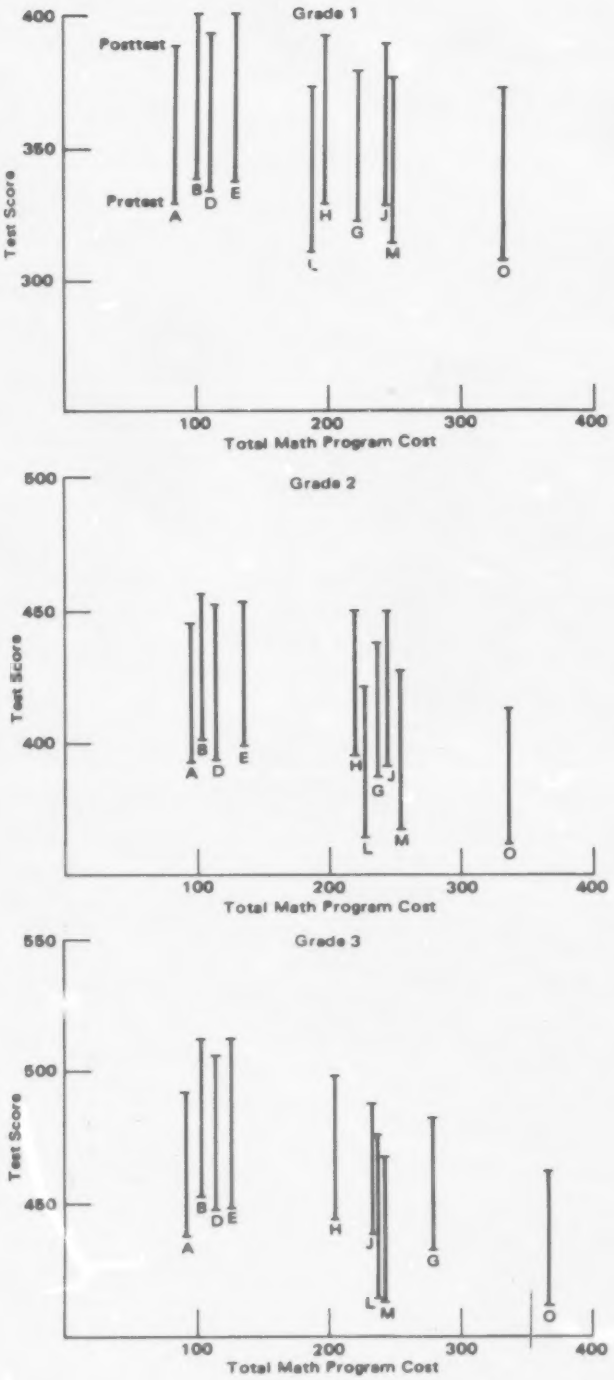






A. Minimal program with no seatwork.
B. Minimal program with seatwork.
D. Group instruction with no seatwork.
E. Group instruction with seatwork.
F. Group instruction plus aide.
G. Individual instruction with no seatwork.
H. Individual instruction with seatwork.
I. Individual instruction plus aide.
J. Individual instruction plus group instruction
L. Special teacher.
M. Special teacher plus group instruction.
O. Individual instruction and special teacher.
P. Individual instruction and special teacher plus group instruction.

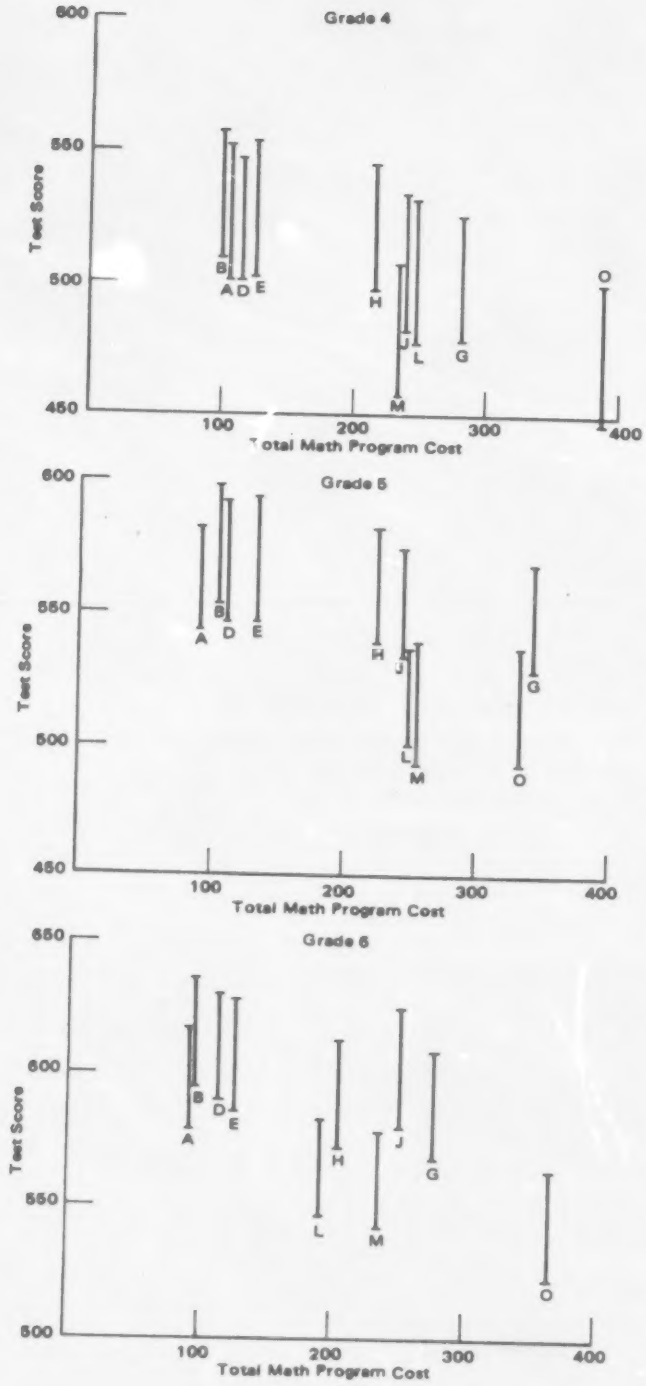
Figure 4-5 (Continued)



A. Minimal program with no seatwork.
B. Minimal program with seatwork.
D. Group instruction with no seatwork.
E. Group instruction with seatwork.
F. Group instruction plus aide.
G. Individual instruction with no seatwork.
H. Individual instruction with seatwork.
I. Individual instruction plus aide.
J. Individual instruction plus group instruction
L. Special teacher.
M. Special teacher plus group instruction.
O. Individual instruction and special teacher.
P. Individual instruction and special teacher plus group instruction.

Figure 4-6

Math Achievement Performance *Versus* Program Cost
by Instructional Configuration Within Grade Level
(see Table 4-13 for Configuration Code)



A. Minimal program with no seatwork.
B. Minimal program with seatwork.
D. Group instruction with no seatwork.
E. Group instruction with seatwork.
F. Group instruction plus aide.
G. Individual instruction with no seatwork.
H. Individual instruction with seatwork.
I. Individual instruction plus aide.
J. Individual instruction plus group instruction
L. Special teacher.
M. Special teacher plus group instruction.
O. Individual instruction and special teacher.
P. Individual instruction and special teacher plus group instruction.

Figure 4-6 (Continued)

Table 4-17

Rankings of Regression Coefficients for Reading Program Cost Within Instructional Configurations (Coefficients in Parentheses)

		Grade					
		1	2	3	4	5	6
Minimal Program With no seatwork	A.	—	—	1 (.04)	9 (–.03)	5 (.00)	9 (–.01)
With seatwork	B.	—	1 (.10)	11 (–.04)	11 (–.03)	4 (.01)	6 (–.00)*
Group Instruction With no seatwork	D.	2 (.04)	3 (.01)	7 (–.02)	3 (–.00)	8 (–.01)	3 (.01)
With seatwork	E.	3 (.03)	4 (.01)	10 (–.04)	4 (–.00)	3 (.01)	2 (.02)
Plus aide	F.	1 (.05)	—	—	—	—	—
Individual Instruction With no seatwork	G.	4 (.03)	9 (–.02)	4 (.01)	2 (.00)	7 (–.00)	7 (–.00)
With seatwork	H.	5 (.02)	5 (.00)	3 (.01)	10 (–.03)	6 (–.00)	5 (.00)
Plus group instruction	J.	6 (.01)	6 (.00)	9 (–.02)	7 (–.02)	1 (.02)	10 (–.01)
Special Teacher	L.	—	—	2 (.02)	8 (–.03)	11 (–.02)	8 (–.00)
Plus group instruction	M.	8 (.00)	7 (–.01)	6 (–.01)	5 (–.01)	10 (–.02)	1 (.03)
Individual Instruction and Special Teacher	O.	7 (.00)	8 (–.01)	5 (–.00)	6 (–.02)	9 (–.02)	4 (.01)
Plus group instruction	P.	9 (–.01)	2 (.02)	8 (–.02)	1 (.01)	2 (.02)	—

*No interpretation should be placed on —.00.

Table 4-18

Ranking of Regression Coefficients for Math Program Cost Within Instructional Configuration (Coefficients in Parentheses)

		Grade 1	2	3	4	5	6
Minimal Program							
With no seatwork	A.	1 (.10)	1 (.05)	7 (−.08)	9 (−.10)	8 (−.12)	9 (−.14)
With seatwork	B.	8 (−.02)	2 (−.02)	9 (−.16)	7 (−.04)	4 (−.01)	8 (−.05)
Group Instruction							
With no seatwork	D.	2 (.05)	.9 (−.02)	5 (.00)	8 (−.09)	5 (−.02)	3 (.01)
Individual Instruction							
With no seatwork	G.	9 (−.06)	8 (−.02)	1 (.10)	5 (−.00)	4 (−.01)	7 (−.02)
With seatwork	H.	6 (−.00)	4 (.01)	6 (−.03)	2 (.06)	3 (.01)	5 (−.01)
Plus group instruction	J.	3 (.04)	5 (−.01)	8 (−.09)	4 (−.00)	2 (.02)	4 (.01)
Special Teacher	L.	7 (−.00)	3 (.01)	2 (.05)	3 (.03)	7 (−.03)	6 (−.02)
Plus group instruction	M.	4 (.04)	6 (−.01)	3 (.03)	6 (−.01)	6 (−.02)	1 (.08)
Individual Instruction and Special Teacher	O.	5 (.01)	7 (−.01)	4 (.01)	1 (.06)	1 (.04)	2 (.03)

Table 4-19

Proportions of Posttest Variance Explained Collectively by Program Components, Net of Variance Explained by Pretest, Within Families of Instructional Configurations

	Grade					
	1	2	3	4	5	6
Reading						
Minimal Programs	.02	.02	.00	.00	.00	.00
Group Instruction	.01	.00	.01	.00	.00	.00
Individual Instruction	.02	.00	.00	.01	.00	.00
Special Teachers	.06	.02	.01	.01	.00	.00
Aides	.01	.02	.01	.01	.03	.08
Individual Instruction plus Special Teachers	.03	.02	.02	.02	.02	.02
Math						
Minimal Programs	.01	.01	.02	.01	.01	.01
Group Instruction	.01	.01	.01	.00	.00	.00
Individual Instruction	.01	.02	.02	.00	.01	.01
Special Teachers	.03	.04	.01	.01	.01	.01
Aides	.09	.10	.10	.08	.04	.21
Individual Instruction plus Special Teachers	.05	.03	.03	.06	.02	.02

CHAPTER 5. FINDINGS RELEVANT TO POLICY QUESTIONS

One of the premises behind the adoption of Title I was the belief that increased educational expenditures would result in increased achievement levels among disadvantaged students. In our research, the resources used in instruction have been translated to a comparable dollar-metric in order to investigate CE in terms of this premise.

We have examined the relationships of reading and math achievement to exposure to educational resources, exploring several blocking schemes that have policy interest:

CE selection category
Achievement status
Poverty status
Achievement outliers
Instructional configuration

Our results have been nondecisive in the sense that none of our comparisons among groups of students reveal meaningful differences in cost-effectiveness. On the other hand, we are not quite prepared to conclude that the level of resource utilization has no independent effect on outcome. Though small, the raw regression coefficients that served as our indices of cost-effectiveness frequently exceeded two and three times their standard errors, and were often disturbingly negative.

Taking these results at face value, one might conclude that increased utilization of resources has a nuisance effect that tends to diminish achievement across most of the range of program cost that we observed in our sample. If this were truly the case, we might be able to find a critical cost below which the returns to cost are increasing, and above which they are decreasing. We believe such critical points should have been revealed by our models that specified cost in both first and second order terms, but the evidence was not decisive one way or the other.

We are confident that our cost metric is not at fault. For example, one might question their use in models with a single cost variable, since this assumes equal returns irrespective of the ways in which resources are deployed. We believe we have addressed this question in the analyses where the data are blocked by program configuration, and total cost is disaggregated into ten program component costs. Another possibility is that the utilization of resources has beneficial effects, but the benefits do not advance as rapidly as do the costs. We have addressed that question by substituting program component *hours* for program component *costs* in some of our trials; we still obtained negative regression coefficients for the individualized-instruction components and the special-teacher-instruction components. Therefore, the cause for the negative relationships is not in the cost metric alone.

A more probable explanation for the slight negativity is that, on balance, resources tend to be allocated with more intensity to low achievers. The allocation is dynamic across time, depending on student performance: low achievers who show marked improvement move on to less labor-intensive instructional programs; students in less labor-intensive programs who

progress slowly are reassigned to more expensive programs. According to this view, the allocation effect swamps whatever therapeutic effects resource utilization might have. The allocation would operate within classroom, and therefore could dominate within most of our blocking arrangements as well as over grade levels taken as a whole. Certainly, it was clear from the data in Chapter 3 that there is a consistent negative relationship between cost and pretest, and between cost and posttest. This interpretation is further reinforced by the results for program components. The components representing more traditional group modes of instruction exhibit more positive relationships to achievement than do the components associated with individualized and special teacher modes of instruction, and students whose rates of learning are low are more likely to receive instruction by special teachers. This apparently holds true independent of CE selection status. The coefficients for these more intensive treatments were small and negative in the separate regressions performed on the data of non-CE students, who exhibit much lower average program costs.

Much the same reasoning obtains here as in the area of health care. That is, grieviously ill patients consume more costly and intensive medical care; yet the returns to such medical care, as measured in success rates (cures), are probably lower than those encountered with less seriously ill patients who receive less costly or intensive treatment. In effect, then, the same non-equivalence among treatment groups exists in terms of allocating services.

Given these circumstances, one might be tempted to conclude that, with all this spurious negativity, even modest evidence of cost-effectiveness should be given great credence. Yet, we must caution that it is probably dangerous even to assume that a less negative regression coefficient indicates more cost-effective resource utilization; it may simply indicate less allocative efficiency within the block of students represented by that coefficient.

There are, of course, other possibilities for explaining why a hypothetically positive cost-effectiveness relationship might not be manifest in the results of our analyses. For example, the psychological characteristics of students (not measured here) may interact importantly with the manner in which educational resources are deployed. Or, the general quality of instructional programs may vary inversely, on balance, with resource quantity. The quality differences might include those having to do with the nature of instructional staff and/or program implementation.

THE POLICY/RESEARCH QUESTIONS

We now turn to a summary discussion of our results as they apply to the policy/research questions presented in Chapter 1. These research questions provided the basis underlying our investigation of the relationship of resources to student achievement.

To What Extent Is the Use of Instructional Resources Associated With Growth in Student Achievement?

An examination of the results reported in Chapter 4 strongly suggests that higher utilization of resources does not result in higher student achievement. CE students learn about as much during each school year as their non-CE peers, but the differences in achievement status that exist at the beginning of the year remain, despite the growth exhibited during the school year.

The costs of the reading and math programs received by the CE students, however, are substantially greater (especially in reading; less so in math) than the program costs for the non-CE students.

The regression coefficients of our cost variable are small and most often negative, whether considered for the full complement of students in each grade or for the policy-relevant subsets of students used in the analyses. Regressions yield very similar results, whether the dependent measure is specified as posttest score, residual gain, or raw gain.

In other analyses, a test of the diminishing returns hypothesis was obtained by adding the square of total cost to the regression equation. The results indicated extremely small regression coefficients and negligible increments to the coefficient of determination (R^2) associated with the squared term. This result confirms that cost is negatively associated with achievement throughout the range of costs.

In the Title I and Other-CE subsamples within each grade, the regression coefficients of the total program cost remain small. In some grades, the signs of the coefficients become positive rather than negative; however, in those same cases, the stability of the coefficients is lower (i.e., they are even smaller with respect to their standard errors). In no instance is there both a positive and stable coefficient relating achievement to cost within any of the two strata of Title I or Other-CE students.

In comparing students who gained much more than was projected from their pretests with those who gained much less, it was found that the high-gainers generally received programs with lower costs. A notable exception was in grades three through six, where the Title I students who were high-gainers received the higher cost programs.

What Particular Combinations of Resources Are More Cost-Effective for Increasing Growth in Student Achievement?

The analyses of students blocked by instructional configuration (combinations of resources) yielded results consistent with those obtained from the regressions against total program cost. The less costly and less labor-intensive configurations have an apparent cost-effectiveness advantage over the more costly configurations.

Our data do not show great differences between configurations for low-gain and high-gain students, although there are a few configurations that are not typically shared by low-gainers and high-gainers. High-gaining primary students are frequently found in configurations that are less labor intensive, while low-gaining primary students are frequently in the more labor-intensive configurations. Conversely, high-gaining math students in the upper grades often have more labor-intensive programs.

When average pretest and posttest scores for the various configurations are charted against average program costs, the more expensive configurations are employed for students with lower pretest scores. This tendency, which holds for both reading and math, becomes more pronounced in the upper grades. Students in configurations that employ individualized instruction by the regular teacher tend to have higher pretest scores than do students in

configurations that employ special teachers, although the average costs for the two kinds of configurations are about the same. It is striking that the amount of gain for all groups within a given grade level is so uniform, despite different costs and different beginning achievement levels.

In an attempt to obtain cost-effectiveness indices for the configurations that could be easily compared, regression computations were performed with posttest score as the dependent variable and pretest score and total reading (and math) program cost as the independent variables. The regression coefficients for cost that resulted were of trivial magnitudes, and their rankings among configurations within grades did not form a sensible pattern across grades. A second set of regressions specified the ten separate program component costs rather than total program cost. The program component costs result in somewhat higher regression multiple R^2 for the configurations, but the proportions of posttest variance explained by the cost variables (net of variance explained by pretest score) were minimal for all configurations in all grades.

At What Grade Levels Is Compensatory Education More Cost-Effective?

We intended to examine this question by first making within-grade contrasts between CE and non-CE regression coefficients (i.e., "indices of cost-effectiveness"), then comparing these contrasts across grade levels. The reason for comparing contrasts instead of the regression coefficients directly was to accommodate the fact that the nature of academic growth measured by achievement scores is not the same from grade to grade. In any case, our design does not work well because the coefficients turned out to be small and relatively unstable for the CE subsample.

In examining raw gain alone, it is apparent that CE students in grades one, two, three, and five gain about ten percent more in reading than do our comparison groupings; there is very little difference in grades four and six. In math, average grade level gains are sixteen to twenty-four percent higher than the comparison group in grades one, two, five, and six; in grades three and four, the gains are eight and zero percent higher, respectively. Comparing the same groups for cost per unit of gain, the differences are higher in the upper grades for both reading and math, suggesting that CE is more cost-effective in the lower grades.

Does Funding Source, Holding Resource Costs Constant, Have an Independent Effect on Educational Outcome?

This question, which most closely relates to an analysis of the overall effectiveness of programs as defined by funding category, was included in the analysis as a test on our underlying assumption that it is not the type of funding but, rather, the level or the use of funds that would prove important in relation to student outcomes. This assumption was based on the belief that, in spite of differences in regulations tied to funding, a Title I dollar, for example, is not different from any other dollar.

In those analyses that subset our sample of students within grades according to their CE selection status (Title I, Other-CE, and non-CE), the results across selection categories were

quite similar. This is in spite of large cost differences in the programs received as well as differences in pretest levels of the students across categories.

Funding source, holding program cost constant, does not have an independent effect on educational outcome. When, for example, the reading programs were stratified by five levels of cost, the percentage gains of the Title I students and the non-CE students were within one to three percentage points of each other. The regression results were similar for all groups of students, including those not participating in any CE program. In terms of the raw differences between pretest and posttest mean achievement scores, CE students appear to be learning as much as non-CE students. The main exception to this occurs in reading scores obtained in the first grade, where the non-CE students made greater gains than the CE students.

In one set of analyses, the Title I students exhibited somewhat more positive results. When students whose posttest scores deviated substantially from the general posttest on pretest regression line were examined, the high-scoring outliers in the Title I group showed higher average costs than the low-scoring outliers in four of the six grades. However, the bulk of these analyses showed that those students who gained less than predicted had more costly programs.

On the whole, then, large and consistent differences in the relation of program cost to achievement growth were not found among different selection categories. In fact, the relationship is similar for both CE students and non-CE students. Most notably, in the analysis of the comparison group of non-CE students from non-CE schools whose teachers indicated the students were in need of CE services, the regression coefficients for program cost were negative; the results for the CE students were similar.

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APPENDIX A

THE RESOURCE COST MODEL

This appendix provides a brief description of the resource cost model (RCM) used in estimating the costs of reading and math programs for each of the 95,000 students in our study. (Readers who are interested in a more detailed description of the RCM are referred to Appendix A of Technical Report # 6, Resource Analysis of Compensatory Education.)

The RCM is both an abstraction of the instructional process (with respect to calculating the costs of instruction) and a series of operations and processing activities that actually produce the cost estimates. The RCM will be described by (1) providing an overview of its structure, (2) detailing the model inputs, (3) describing the model operation of translating (descriptions of the quantities of resources used) inputs into estimates of cost, and (4) describing the types of cost estimates provided by the model.

Overview. The structure of the model is depicted in Figure A-1. The inputs to the resource-cost model are of two types: (1) those that measure the quantity (Q) of the resources used, and (2) those that give a price per unit (P) of the resources. The questionnaire item responses on resource-use provide the Q inputs, and the unit price of resources developed through pricing algorithms provide the P inputs. The model multiplies the quantities of resource-use by the prices per unit of resource-use and sums or apportions these products to achieve the values of cost variables associated with an individual student's programs. These cost variables, the model outputs, are identified either in terms of the type of resource variable or the type of instructional program component.

The quantities of the resources are measured at the organizational level, where use varies. These levels are student, class, and school. As examples, the use of instructional staff of various types in different group sizes is measured at the student level; the use of instructional equipment and materials is measured at the classroom level; and the use of schoolwide instructional support personnel, such as media specialists, is measured at the school level.

Model Inputs. Responses from the Student Participation and Attendance Record (SPAR) and for certain items from the Teacher Questionnaire (Sections B and C) and from the Principal Questionnaire (Section B) provide data on type, frequency of use, and characteristics of the resources used for an individual student's instructional program. (The instruments are described in more detail in Hemenway, et al., 1978). These data provide information on the quantity (Q) for each resource variable. The major inputs used in estimating the instructional program cost are depicted in Figure A-2. Pricing algorithms are used to generate the standard prices (P) for the measures of resource-use for student-level instructional programs. Briefly stated, the process combines measures of resource-use, and averages of the particular prices prevailing in a subsample of the districts, in order to calculate the standard price values. One reason for basing the pricing algorithms on subsample data was to permit the use of less precisely specified resource-use measures in the larger sample, thereby reducing both the respondent burden and the cost of data collection. Less precision here means, for example, that the teacher was not asked to specify the number of pieces of equipment being used but simply to respond that sound equipment was being used, for example, once a week.

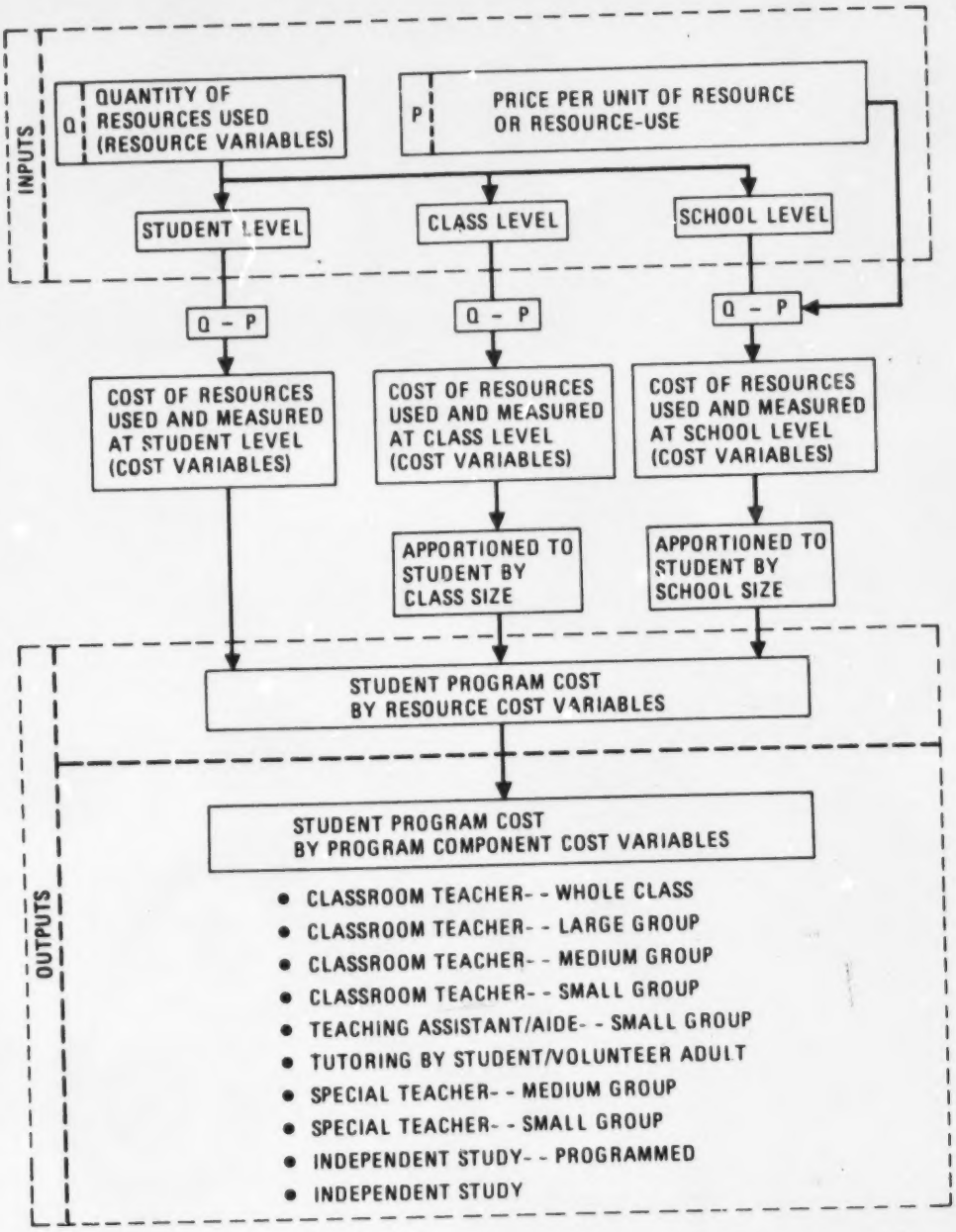
INPUTS
Q
QUANTITY OF RESOURCES USED (RESOURCE VARIABLES)
P
PRICE PER UNIT OF RESOURCE OR RESOURCE-USE
STUDENT LEVEL
CLASS LEVEL
SCHOOL LEVEL
Q - P
Q - P
Q - P
COST OF RESOURCES USED AND MEASURED AT STUDENT LEVEL (COST VARIABLES)
COST OF RESOURCES USED AND MEASURED AT CLASS LEVEL (COST VARIABLES)
COST OF RESOURCES USED AND MEASURED AT SCHOOL LEVEL (COST VARIABLES)
APPORTIONED TO STUDENT BY CLASS SIZE
APPORTIONED TO STUDENT BY SCHOOL SIZE
STUDENT PROGRAM COST BY RESOURCE COST VARIABLES
OUTPUTS
STUDENT PROGRAM COST BY PROGRAM COMPONENT COST VARIABLES
• CLASSROOM TEACHER- - WHOLE CLASS
• CLASSROOM TEACHER- - LARGE GROUP
• CLASSROOM TEACHER- - MEDIUM GROUP
• CLASSROOM TEACHER- - SMALL GROUP
• TEACHING ASSISTANT/AIDE- - SMALL GROUP
• TUTORING BY STUDENT/VOLUNTEER ADULT
• SPECIAL TEACHER- - MEDIUM GROUP
• SPECIAL TEACHER- - SMALL GROUP
• INDEPENDENT STUDY- - PROGRAMMED
• INDEPENDENT STUDY

Figure A-1

Overview of Resource/Cost Model:
Resource Variables to Cost Variables to Program Component Costs

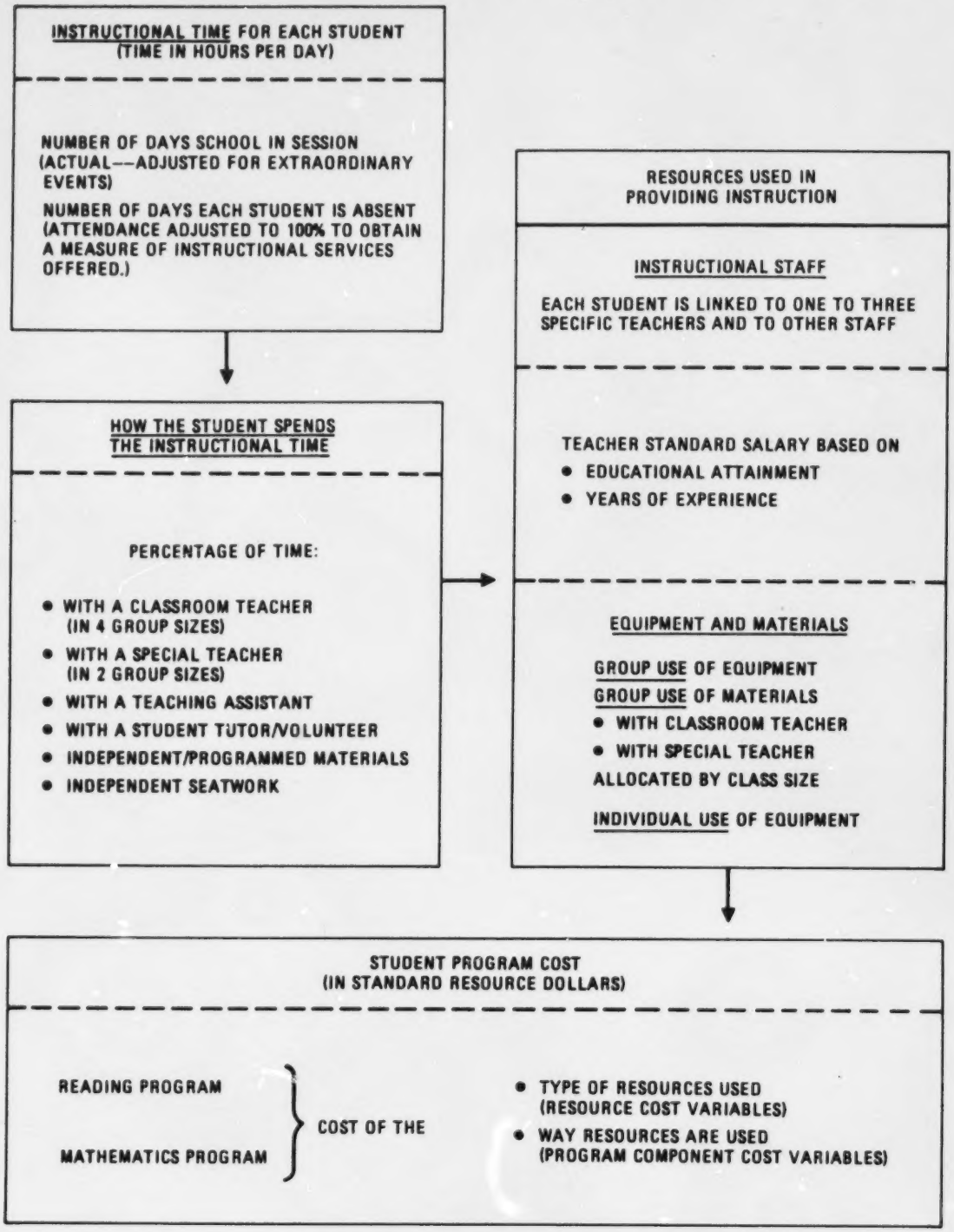
INSTRUCTIONAL TIME FOR EACH STUDENT
(TIME IN HOURS PER DAY)
NUMBER OF DAYS SCHOOL IN SESSION (ACTUAL—ADJUSTED FOR EXTRAORDINARY EVENTS)
NUMBER OF DAYS EACH STUDENT IS ABSENT (ATTENDANCE ADJUSTED TO 100% TO OBTAIN A MEASURE OF INSTRUCTIONAL SERVICES OFFERED.)
HOW THE STUDENT SPENDS THE INSTRUCTIONAL TIME
PERCENTAGE OF TIME:
• WITH A CLASSROOM TEACHER (IN 4 GROUP SIZES)
• WITH A SPECIAL TEACHER (IN 2 GROUP SIZES)
• WITH A TEACHING ASSISTANT
• WITH A STUDENT TUTOR/VOLUNTEER
• INDEPENDENT/PROGRAMMED MATERIALS
• INDEPENDENT SEATWORK
RESOURCES USED IN PROVIDING INSTRUCTION
INSTRUCTIONAL STAFF
EACH STUDENT IS LINKED TO ONE TO THREE SPECIFIC TEACHERS AND TO OTHER STAFF
TEACHER STANDARD SALARY BASED ON
• EDUCATIONAL ATTAINMENT
• YEARS OF EXPERIENCE
EQUIPMENT AND MATERIALS
GROUP USE OF EQUIPMENT
GROUP USE OF MATERIALS
• WITH CLASSROOM TEACHER
• WITH SPECIAL TEACHER
ALLOCATED BY CLASS SIZE
INDIVIDUAL USE OF EQUIPMENT
STUDENT PROGRAM COST
(IN STANDARD RESOURCE DOLLARS)
READING PROGRAM
MATHEMATICS PROGRAM
COST OF THE
• TYPE OF RESOURCES USED (RESOURCE COST VARIABLES)
• WAY RESOURCES ARE USED (PROGRAM COMPONENT COST VARIABLES)

Figure A-2

The Major Determining Factors of Instructional Program Cost

The standard prices that result from the algorithms are either the price of a single unit of resource—teacher salary—or the price that is related to the level of use for a particular type of resource—the use of sound equipment once a week. Different kinds of pricing algorithms are used to develop the prices for staff salaries, equipment, materials, and the categories of direct instructional support.

The pricing algorithms for the price of a unit of resource, in this case the teacher, is discussed here. In the RCM, the teacher salary is a surrogate for the qualities of a specific teacher. The teacher salary figure, or the standard price for a teacher, reflects:

(1) the mean base salary for the category
(2) an increment for years of education
(3) an increment for years in teaching

Each teacher who is identified as a classroom teacher and who has the same responses in (2) and (3) above is considered a comparable resource and is assigned the same standard price or salary, regardless of the actual salaries paid in the specific school district.

For the analyses of the cost and outcome, a constant salary for all teachers was also used in the RCM. This modification in the model was based on this rationale: It is unfair to expect those students who happened to be assigned to a teacher with, for example, twenty years of experience, to achieve more than those students assigned to a less experienced teacher.

The prices for the various categories of equipment and materials were constructed in a different fashion. The data on resources available in the schools of our data collection subsample were used to generate a combined inventory cost-per-year estimate for each category of equipment and materials. The combined inventory cost (for each category) was then distributed among the appropriate pattern-of-use response items obtained from the SES Teacher Questionnaire B for reading and Teacher Questionnaire C for math.

Distributions among the pattern-of-use responses were obtained by scaling the questionnaire responses on a one-use-per month basis. Next, each scaled response score was weighted by the respective number of the subsample teachers responding. The combined inventory cost is the sum of the products obtained by multiplying the frequency of the teacher responses, the scaled response values, and the price. Solving for P, the price, yields the price-per-year for the one-use-per month response.

The outcome of this procedure is a series of prices for our categories of equipment and materials. The RCM used these prices in combination with the teacher responses from the entire SES sample to generate a cost-per-year for each level of use.

Model Operation. Five subprograms (0100 to 0500) comprise the RCM. The purpose and nature of the five subprograms are briefly described. The RCM flow chart for these subprograms is shown in Figure A-3. Resource cost data tapes (containing the individual student cost records that are the outputs of the model) have been incorporated in the SES data base at SDC.

- *Subprogram 0100.* Generates records on the basis of the Student-Teacher Linkage Roster (STLR) that can be matched by teacher ID number against the Teacher Extract File. (The Teacher Extract File is a separate file that extracts appropriate data from the SES teacher-specific instruments.) For each teacher specified on the STLR, a teacher linkage record is created.
  Inputs: Student-Teacher Linkage Roster File
  Output: Teacher Linkage File

- *Subprogram 0200.* Obtains teacher information relating to individual students. The Teacher Linkage File and the Teacher Extract File are matched on school and teacher ID numbers.
  Inputs: Teacher Linkage File and Teacher Extract File
  Output: Student-Teacher File

- *Subprogram 0300.* Generates a file (SPARMPR) combining information contained in the Student Participation and Attendance Record for reading and for math (SPARM) and in the Principal Questionnaires, Section A and B, (PQAB). Input files are matched on school and student ID numbers; for each match a SPARMPR record is created.
  Inputs: SPARM File and Principal File
  Output: Combined SPARM and Principal File-SPARMPR File

- *Subprograms 0400.* Combines information from the SPARMPR file of Subprogram 0300 and the Student-Teacher Linkage File of Subprogram 0200. Produces a student resource record.
  Inputs: SPARMPR File and Student-Teacher Linkage File
  Output: Student Resource Record File

- *Subprogram 0500.* Creates the Resource-Program file from the student resource record. Incorporates the standard salary schedule matrix, other prices and the adjustment factors of quantity, length, size and time.
  Inputs: Student Resource Record File
  Output: Reading and Math Resource-Program Files

The Model Outputs. The subprogram 0500 output, described above as the Reading and Math Resource-Program Files, produces individual student total reading and math program costs in two forms. One is total cost showing subtotals by the *resource* cost variables; the other form shows total cost by the subtotals for the *program* component cost variables.

The resource cost variables are simply the costs by type of resource. The program component cost variables are the costs by the delivery configuration within which the student receives instruction. The total program costs by program component cost variable are shown in Tables B-1 through B-12 in Appendix B. The program components correspond to the categories on the Student Participation and Attendance Record (SPAR). These categories are the choices the SES teachers have available for describing how a student's time is spent in reading and math instruction. The restructuring of the resource cost variables into the ten program component cost variables is shown in Figure A-4.

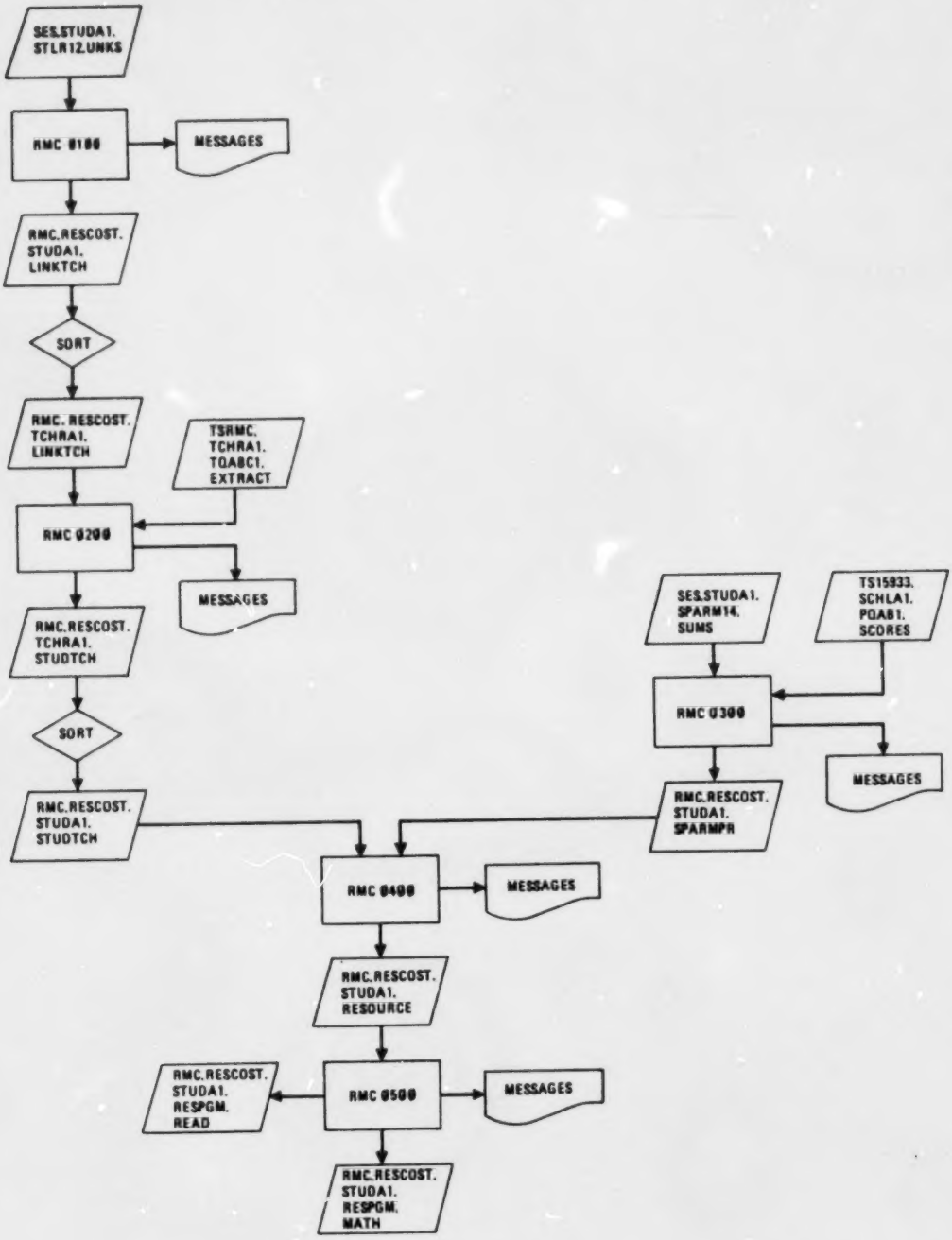

Figure A-3

Subprogram Flow Chart for the Resource Cost Model

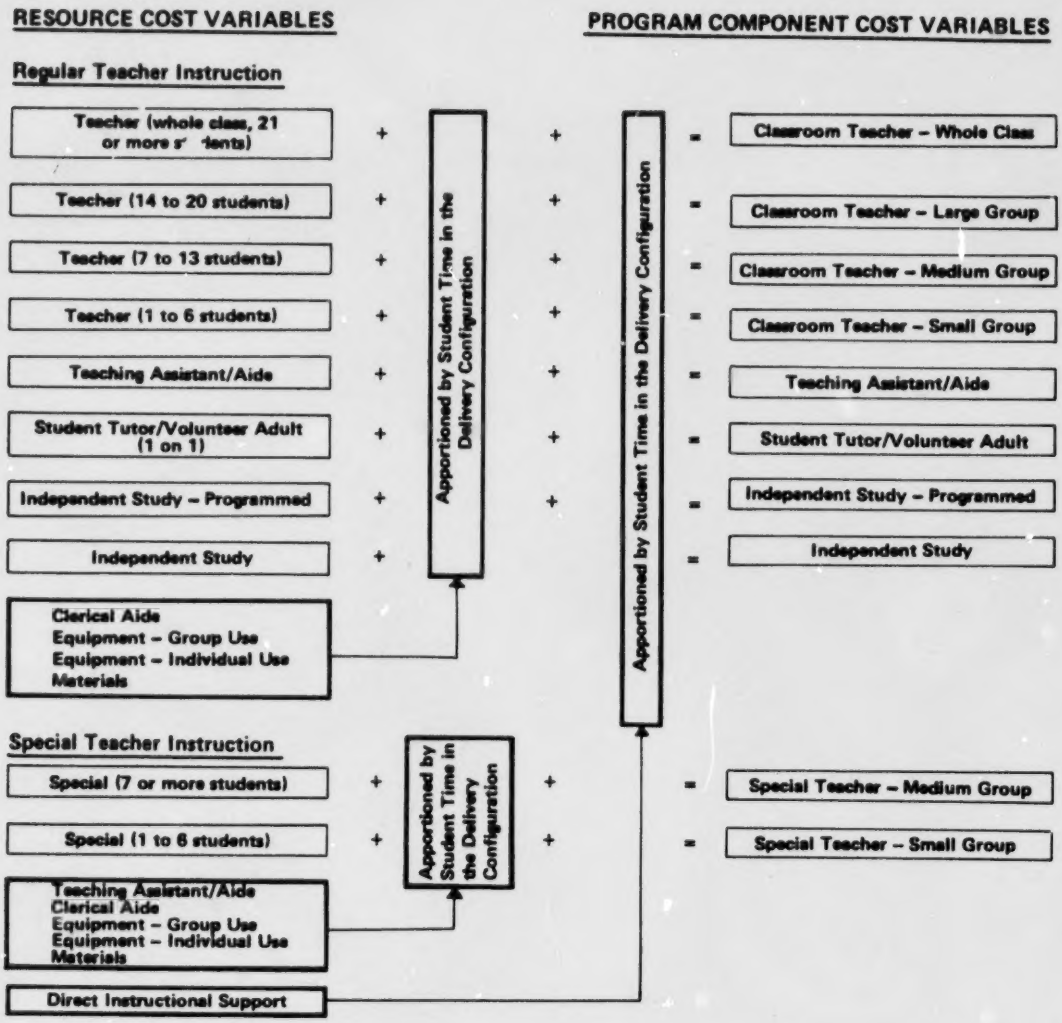
RESOURCE COST VARIABLES
PROGRAM COMPONENT COST VARIABLES
Regular Teacher Instruction
Teacher (whole class, 21 or more students)
Teacher (14 to 20 students)
Teacher (7 to 13 students)
Teacher (1 to 6 students)
Teaching Assistant/Aide
Student Tutor/Volunteer Adult (1 on 1)
Independent Study – Programmed
Independent Study
Clerical Aide
Equipment – Group Use
Equipment – Individual Use
Materials
Apportioned by Student Time in the Delivery Configuration
Apportioned by Student Time in the Delivery Configuration
Classroom Teacher – Whole Class
Classroom Teacher – Large Group
Classroom Teacher – Medium Group
Classroom Teacher – Small Group
Teaching Assistant/Aide
Student Tutor/Volunteer Adult
Independent Study – Programmed
Independent Study
Special Teacher Instruction
Special (7 or more students)
Special (1 to 6 students)
Teaching Assistant/Aide
Clerical Aide
Equipment – Group Use
Equipment – Individual Use
Materials
Direct Instructional Support
Apportioned by Student Time in the Delivery Configuration
Special Teacher – Medium Group
Special Teacher – Small Group

Figure A-4

Restructuring the Resource Cost Variables Into Component Cost Variables

The program component cost is the sum of the corresponding resource cost variable for personnel plus an apportioned share of the cost for equipment, materials, and instructional support. In brief, the resource cost variables let us examine the resource mixture of the individual student's total program cost; the program component cost variables permit an examination of the total program cost in terms of the cost of the different delivery configurations used to provide instruction.

APPENDIX B

PROGRAM COST BY CE SELECTION CATEGORY

This appendix presents the summary cost data for the program component costs by student CE selection category. The data are for all students for whom we have information on the resources used in providing their reading and math instruction. Because not all of these students remained in the SES for the entire year (i.e., the pretest or posttest scores were not available), the numbers of students shown are higher than the numbers of students entering our analyses of cost and effectiveness.

The number of students shown for each program component represents the students receiving instruction by means of that particular component, and the cost represents the mean cost of the program component for those students.

Table B-1

Cost of Reading Program Components by Student CE Selection Categories—First Grade (in Standard Resource Dollars)

Reading Program Components	CE Selection Category											
	Title I Students in Title I Schools		Other-CE Students in Title I School		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE Schools	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	35	(1939)	34	(736)	36	(326)	43	(5757)	38	(2541)	60	(1880)
Large Group	14	(2251)	18	(833)	13	(394)	18	(6608)	22	(2720)	21	(1678)
Medium Group	118	(2320)	116	(816)	113	(397)	137	(6551)	142	(2624)	141	(1815)
Small Group	202	(1905)	200	(765)	239	(446)	209	(4380)	222	(1754)	204	(1040)
Teaching Assistant/Aide												
Small Group	48	(1940)	41	(635)	35	(260)	39	(1881)	36	(432)	47	(469)
Special Teacher												
Medium Group	94	(963)	55	(144)	56	(141)	47	(270)	35	(68)	36	(15)
Small Group	179	(1196)	182	(274)	156	(250)	114	(481)	74	(113)	88	(49)
Tutoring by Student/Volunteer Adult	9	(596)	11	(239)	8	(117)	12	(961)	16	(471)	12	(379)
Independent Study—Programmed	28	(801)	14	(233)	28	(137)	28	(1663)	28	(913)	14	(290)
Independent Study	36	(2840)	36	(1035)	45	(594)	46	(7904)	51	(3520)	41	(2305)
Reading Total Program Cost	411	(3131)	373	(1111)	401	(635)	325	(8418)	311	(3705)	302	(2473)

Table B-2

Cost of Reading Program Components by Student CE Selection Categories—Second Grade (in Standard Resource Dollars)

Reading Program Components	CE Selection Category											
	Title I Students in Title I Schools		Other-CE Students in Title I School		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE Schools	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	41	(1628)	43	(442)	32	(376)	46	(3998)	40	(1799)	41	(1422)
Large Group	15	(2225)	15	(721)	20	(490)	19	(4839)	28	(2420)	29	(1705)
Medium Group	129	(2254)	126	(739)	124	(467)	138	(4787)	138	(2165)	125	(1663)
Small Group	207	(1815)	199	(569)	216	(470)	212	(3620)	237	(1176)	160	(1011)
Teaching Assistant/Aide												
Small Group	44	(1761)	42	(445)	33	(255)	31	(1192)	44	(355)	26	(430)
Special Teacher												
Medium Group	91	(1218)	47	(138)	60	(234)	47	(368)	27	(103)	33	(78)
Small Group	186	(1380)	186	(304)	177	(402)	124	(394)	109	(133)	106	(120)
Tutoring by Student/Volunteer Adult	10	(530)	12	(112)	10	(127)	16	(687)	11	(346)	12	(347)
Independent Study—Programmed	27	(983)	25	(121)	23	(196)	33	(1661)	28	(737)	15	(420)
Independent Study	34	(2975)	43	(942)	44	(745)	45	(6567)	52	(3071)	40	(2121)
Reading Total Program Cost	416	(3227)	362	(999)	402	(778)	310	(6978)	291	(3206)	272	(2196)

Table B-3

Cost of Reading Program Components by Student CE Selection Categories—Third Grade (in Standard Resource Dollars)

Reading Program Components	CE Selection Category											
	Title I Students in Title I Schools		Other-CE Students in Title I School		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE Schools	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	40	(1625)	30	(447)	43	(359)	42	(3653)	43	(1790)	39	(1503)
Large Group	17	(2111)	13	(670)	19	(428)	22	(4868)	35	(2361)	25	(1626)
Medium Group	106	(2062)	116	(666)	101	(378)	113	(4394)	122	(2071)	121	(1398)
Small Group	182	(1811)	178	(552)	211	(384)	174	(3147)	197	(1105)	190	(901)
Teaching Assistant/Aide												
Small Group	41	(1759)	42	(370)	37	(234)	28	(1184)	20	(245)	30	(178)
Special Teacher												
Medium Group	83	(1243)	48	(204)	74	(196)	40	(360)	28	(111)	36	(36)
Small Group	162	(1409)	183	(304)	186	(312)	111	(533)	94	(148)	91	(105)
Tutoring by Student/Volunteer Adult	9	(430)	8	(78)	6	(101)	10	(632)	11	(243)	6	(152)
Independent Study—Programmed	23	(917)	19	(278)	22	(125)	25	(1514)	25	(720)	9	(241)
Independent Study	35	(2783)	41	(903)	37	(619)	44	(6406)	43	(2959)	38	(2105)
Reading Total Program Cost	375	(3123)	342	(937)	367	(680)	257	(6763)	242	(3299)	245	(2200)

Table B-4

Cost of Reading Program Components by Student CE Selection Categories—Fourth Grade (in Standard Resource Dollars)

Reading Program Components	CE Selection Category											
	Title I Students in Title I Schools		Other-CE Students in Title I School		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE Schools	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	47	(1233)	42	(346)	43	(305)	48	(4173)	45	(2154)	53	(1486)
Large Group	23	(1592)	10	(537)	20	(444)	26	(4692)	26	(2337)	43	(1358)
Medium Group	95	(1515)	108	(565)	89	(404)	99	(4024)	90	(2025)	87	(1040)
Small Group	177	(1266)	196	(419)	130	(347)	157	(2628)	106	(1211)	127	(777)
Teaching Assistant/Aide												
Small Group	34	(1156)	30	(277)	29	(218)	24	(801)	24	(216)	8	(52)
Special Teacher												
Medium Group	91	(963)	72	(204)	71	(192)	47	(413)	36	(75)	99	(22)
Small Group	172	(1191)	182	(263)	178	(304)	116	(438)	89	(134)	156	(86)
Tutoring by Student/Volunteer Adult	8	(259)	6	(66)	8	(80)	7	(517)	9	(176)	4	(92)
Independent Study—Programmed	25	(707)	14	(213)	26	(206)	16	(1623)	29	(855)	13	(328)
Independent Study	31	(2214)	37	(787)	37	(545)	36	(6395)	36	(3098)	30	(1941)
Reading Total Program Cost	355	(2481)	306	(868)	315	(641)	203	(7253)	182	(3551)	193	(2102)

Table B-5

Cost of Reading Program Components by Student CE Selection Categories—Fifth Grade (in Standard Resource Dollars)

Reading Program Components	CE Selection Category											
	Title I Students in Title I Schools		Other-CE Students in Title I School		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE School	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	52	(1195)	41	(279)	51	(291)	51	(4481)	49	(2654)	50	(1740)
Large Group	21	(1353)	14	(463)	15	(396)	26	(4445)	25	(2271)	40	(1196)
Medium Group	88	(1227)	106	(470)	101	(363)	92	(3775)	91	(2041)	89	(1091)
Small Group	168	(1101)	163	(337)	136	(304)	146	(2653)	100	(1252)	158	(771)
Teaching Assistant/Aide												
Small Group	37	(1036)	34	(173)	25	(213)	30	(603)	38	(176)	13	(90)
Special Teacher												
Medium Group	79	(715)	75	(165)	72	(142)	35	(314)	22	(108)	61	(149)
Small Group	176	(937)	163	(244)	178	(245)	126	(402)	101	(92)	85	(149)
Tutoring by Student/Volunteer Adult	9	(183)	6	(48)	11	(129)	7	(369)	9	(229)	8	(162)
Independent Study—Programmed	24	(751)	20	(217)	25	(167)	19	(1671)	24	(1115)	30	(638)
Independent Study	30	(1826)	36	(637)	30	(556)	34	(6427)	32	(3443)	31	(1954)
Reading Total Program Cost	318	(2251)	276	(750)	293	(611)	188	(7479)	168	(3897)	193	(2374)

Table B-6

Cost of Reading Program Components by Student CE Selection Categories—Sixth Grade (in Standard Resource Dollars)

Reading Program Components	CE Selection Category											
	Title I Students in Title I Schools		Other-CE Students in Title I School		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE Schools	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	41	(964)	39	(445)	43	(389)	46	(4728)	46	(4742)	52	(2036)
Large Group	26	(1352)	31	(570)	26	(332)	28	(4244)	29	(3201)	45	(1180)
Medium Group	94	(1163)	73	(494)	87	(295)	79	(3423)	75	(2573)	86	(719)
Small Group	150	(881)	117	(453)	131	(259)	110	(2820)	127	(1874)	172	(700)
Teaching Assistant/Aide												
Small Group	34	(846)	33	(163)	30	(209)	15	(693)	20	(236)	10	(34)
Special Teacher												
Medium Group	98	(657)	79	(183)	79	(169)	47	(319)	38	(777)	70	(278)
Small Group	190	(824)	146	(201)	174	(242)	101	(461)	69	(610)	110	(128)
Tutoring by Student/Volunteer Adult	8	(216)	5	(43)	9	(123)	6	(450)	6	(338)	10	(134)
Independent Study—Programmed	20	(776)	22	(225)	23	(238)	17	(2238)	20	(1618)	28	(599)
Independent Study	28	(1719)	26	(731)	28	(568)	31	(6403)	27	(5403)	24	(2171)
Reading Total Program Cost	317	(2004)	232	(852)	261	(647)	162	(7519)	161	(6177)	167	(2670)

Table B-7

Cost of Math Program Components by Student CE Selection Categories—First Grade (in Standard Resource Dollars)

Math Program Components	CE Selection Category									
	Title I Students in Title I Schools		Other-CE Students in Title I Schools		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE Schools	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	34	(1230)	31	(669)	34	(209)	44	(7946)	49	(3305)	51	(2195)
Large Group	33	(514)	38	(404)	39	(76)	42	(2810)	36	(928)	43	(667)
Medium Group	68	(1050)	42	(480)	57	(175)	56	(3458)	52	(1070)	48	(551)
Small Group	114	(811)	83	(522)	105	(223)	85	(3653)	74	(1283)	76	(988)
Teaching Assistant/Aide												
Small Group	31	(1083)	22	(466)	23	(223)	20	(1432)	13	(183)	19	(235)
Special Teacher												
Medium Group	62	(601)	28	(45)	40	(42)	43	(265)	15	(60)	28	(41)
Small Group	87	(421)	99	(88)	115	(66)	59	(266)	50	(48)	65	(42)
Tutoring by Student/Volunteer Adult	5	(259)	5	(180)	4	(51)	5	(782)	5	(314)	4	(190)
Independent Study—Programmed	15	(361)	11	(89)	8	(25)	11	(794)	5	(161)	5	(99)
Independent Study	21	(1634)	21	(933)	33	(361)	27	(9308)	28	(3828)	27	(2224)
Math Total Program Cost	207	(1795)	144	(980)	189	(370)	131	(9912)	115	(3980)	126	(2469)

Table B-8

Cost of Math Program Components by Student CE Selection Categories—Second Grade (in Standard Resource Dollars)

Math Program Components	CE Selection Category											
	Title I Students in Title I Schools		Other-CE Students in Title I Schools		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE Schools	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	39	(1193)	34	(547)	43	(185)	49	(6811)	46	(2895)	48	(1912)
Large Group	36	(593)	36	(233)	25	(62)	39	(2346)	39	(986)	47	(539)
Medium Group	60	(919)	53	(418)	96	(147)	60	(2669)	50	(1100)	46	(829)
Small Group	105	(798)	77	(368)	100	(150)	95	(3349)	70	(1342)	75	(842)
Teaching Assistant/Aide												
Small Group	25	(1092)	25	(403)	22	(196)	20	(1044)	17	(288)	11	(262)
Special Teacher												
Medium Group	51	(595)	24	(39)	62	(70)	44	(317)	42	(59)	26	(132)
Small Group	116	(522)	124	(65)	85	(77)	71	(273)	53	(72)	59	(60)
Tutoring by Student/Volunteer Adult	5	(284)	5	(111)	6	(48)	6	(539)	4	(252)	5	(247)
Independent Study—Programmed	15	(472)	18	(66)	12	(54)	13	(1123)	17	(367)	7	(223)
Independent Study	25	(1653)	25	(797)	28	(308)	29	(8042)	29	(3523)	26	(2098)
Math Total Program Cost	210	(1782)	140	(845)	197	(321)	139	(8625)	120	(3680)	130	(2193)

Table B-9

Cost of Math Program Components by Student CE Selection Categories—Third Grade (in Standard Resource Dollars)

Math Program Components	CE Selection Category											
	Title I Students in Title I Schools		Other-CE Students in Title I Schools		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE Schools	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	37	(1285)	41	(495)	51	(272)	47	(6678)	50	(2947)	49	(1900)
Large Group	28	(696)	40	(278)	24	(119)	36	(2261)	37	(1050)	51	(561)
Medium Group	58	(973)	49	(318)	67	(157)	55	(2624)	58	(1075)	64	(632)
Small Group	93	(998)	103	(355)	111	(158)	82	(3149)	96	(1028)	79	(856)
Teaching Assistant/Aide												
Small Group	27	(1129)	26	(249)	25	(189)	18	(1065)	8	(43)	13	(74)
Special Teacher												
Medium Group	56	(673)	55	(92)	64	(65)	32	(318)	35	(77)	9	(19)
Small Group	103	(653)	125	(115)	111	(118)	71	(449)	63	(96)	58	(70)
Tutoring by Student/Volunteer Adult	5	(254)	3	(106)	3	(70)	4	(734)	5	(258)	4	(194)
Independent Study—Programmed	13	(475)	7	(155)	21	(70)	13	(1054)	9	(269)	10	(215)
Independent Study	23	(1654)	28	(682)	29	(355)	29	(7697)	28	(3303)	28	(2093)
Math Total Program Cost	214	(1860)	172	(756)	200	(393)	133	(8260)	125	(3621)	135	(2190)

Table B-10

Cost of Math Program Components by Student CE Selection Categories—Fourth Grade (in Standard Resource Dollars)

Math Program Components	CE Selection Category											
	Title I Students in Title I Schools		Other-CE Students in Title I Schools		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE Schools	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	42	(1166)	40	(524)	49	(295)	50	(6669)	50	(3172)	55	(1727)
Large Group	39	(532)	43	(218)	21	(97)	37	(2310)	37	(1167)	47	(851)
Medium Group	50	(699)	94	(312)	38	(143)	55	(2559)	51	(1092)	45	(835)
Small Group	133	(674)	133	(297)	89	(202)	104	(2854)	71	(1297)	89	(756)
Teaching Assistant/Aide												
Small Group	27	(750)	22	(156)	23	(179)	19	(767)	17	(206)	12	(21)
Special Teacher												
Medium Group	80	(553)	40	(91)	84	(77)	47	(444)	23	(98)	20	(45)
Small Group	125	(507)	145	(176)	166	(107)	106	(442)	80	(139)	86	(57)
Tutoring by Student/Volunteer Adult	8	(194)	5	(41)	3	(62)	6	(665)	6	(244)	5	(105)
Independent Study—Programmed	21	(295)	12	(122)	30	(135)	15	(1405)	10	(449)	11	(105)
Independent Study	24	(1285)	31	(760)	28	(331)	27	(7134)	25	(3405)	23	(1912)
Math Total Program Cost	238	(1520)	192	(818)	209	(389)	139	(8319)	120	(3806)	137	(2126)

Table B-11

Cost of Math Program Components by Student CE Selection Categories—Fifth Grade (in Standard Resource Dollars)

Math Program Components	CE Selection Category											
	Title I Students in Title I Schools		Other-CE Students in Title I Schools		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE Schools	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	46	(1009)	43	(435)	46	(250)	52	(6585)	50	(3518)	55	(2052)
Large Group	38	(291)	39	(155)	46	(56)	41	(2303)	36	(883)	43	(713)
Medium Group	63	(597)	76	(304)	73	(178)	68	(2693)	56	(1186)	64	(589)
Small Group	160	(616)	130	(343)	92	(226)	112	(2804)	82	(1570)	111	(910)
Teaching Assistant/Aide												
Small Group	33	(640)	21	(130)	20	(193)	21	(647)	26	(194)	9	(120)
Special Teacher												
Medium Group	63	(423)	41	(100)	57	(83)	45	(384)	41	(102)	12	(116)
Small Group	165	(498)	122	(153)	133	(114)	81	(520)	58	(129)	51	(99)
Tutoring by Student/Volunteer Adult	7	(178)	4	(44)	7	(73)	5	(666)	4	(352)	4	(166)
Independent Study—Programmed	18	(282)	20	(178)	20	(123)	15	(1420)	12	(698)	17	(308)
Independent Study	25	(1050)	26	(593)	27	(390)	24	(6832)	25	(3582)	24	(2034)
Math Total Program Cost	264	(1351)	194	(708)	202	(420)	141	(8483)	125	(4111)	143	(2405)

Table B-12

Cost of Math Program Components by Student CE Selection Categories—Sixth Grade (in Standard Resource Dollars)

Math Program Components	CE Selection Category											
	Title I Students in Title I Schools		Other-CE Students in Title I Schools		Other-CE Students in Other-CE Schools		Non-CE Students in Title I Schools		Non-CE Students in Other-CE Schools		Non-CE Students in Non-CE Schools	
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)
Classroom Teacher												
Whole Class	43	(684)	38	(597)	47	(332)	49	(6608)	60	(5303)	56	(2289)
Large Group	41	(445)	27	(256)	51	(76)	45	(1898)	45	(1367)	49	(489)
Medium Group	67	(602)	45	(381)	71	(125)	55	(2441)	72	(1373)	75	(863)
Small Group	128	(533)	110	(504)	95	(166)	100	(3109)	82	(1456)	119	(709)
Teaching Assistant/Aide												
Small Group	23	(626)	22	(163)	22	(194)	15	(722)	22	(139)	7	(33)
Special Teacher												
Medium Group	86	(384)	58	(109)	80	(96)	30	(356)	39	(315)	78	(118)
Small Group	139	(393)	110	(130)	130	(110)	67	(478)	40	(249)	60	(67)
Tutoring by Student/Volunteer Adult	7	(166)	4	(106)	7	(92)	5	(589)	4	(442)	4	(220)
Independent Study—Programmed	15	(326)	20	(240)	21	(169)	26	(1300)	11	(924)	10	(365)
Independent Study	24	(874)	24	(716)	24	(403)	24	(6508)	20	(4670)	21	(2083)
Math Total Program Cost	244	(1168)	172	(868)	179	(472)	133	(8297)	118	(6178)	135	(2701)